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USSR Report

MATERIALS SCIENCE AND METALLURGY

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COATINGS

UDC 669.295.84:548.735.6

GRAIN ORIENTATION OF TITANIUM COATINGS ELECTROLYTICALLY DEPOSITED FROM FLUORIDE MELTS

Moscow IZVESTIYA AKADEMII NAUK SSSR: METALLY in Russian No 2, Mar/Apr 80 pp 64-65 manuscript received 5 Feb 79

BALIKHIN, V. S. and MAKAROV, S. B., Moscow

[Abstract] Research was done to produce titanium coatings with grain orientation favoring high corrosion resistance. The fluoride electrolyte contained NaF:LiF = 1:1, K_2TiF_6 = 10%. The soluble anode was titanium sheet. The cathodes were copper or steel plates. Experiments were done to determine the way that deposition temperature and cathode current density affect the grain orientation of the coatings. It was found that the optimum grain-oriented titanium coatings with plane $(11\bar{2}2)$ parallel to the backing are produced by titanium deposition from fluoride electrolytes at 750° C with low cathode current density. This crystallographic plane is intermediate in corrosion resistance between the best (basal) and worst (pyrimidal) faces of the alpha-titanium crystal lattice. For high denisty and minimum roughness of the deposited coating, a temperature of 750-800° C is recommended for the fluoride electrolytes with a reversing current schedule of $D_c = 10\ A/cm^2$ for 45 sec and $D_a = 40\ A/dm^2$ for 6 sec. Figures 1; references 5: 4 Russian, 1 Western.
[126-6610]

UDC 669.018.95:669.715:669.784'781

ANALYSIS OF MATRIX-FIBER INTERACTION IN FIBER COMPOSITES WITH ALUMINUM MATRIX

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 2, 1980
pp 132-136 manuscript received 21 Apr 79

GUZEY, L. S., KHRITOKHIN, N. A., SEDLYAROVA, V. D. and SOKOLOVSKAYA, Ye. M., Moscow

[Abstract] The influence of alloying on the interaction of molten aluminum alloys with boron and carbon fiber hardeners of aluminum fiber composites is analyzed to improve the bond between the matrix and fiber and to reduce the chemical interaction between them. The width of the reaction zone is measured in aluminum-boron fiber and aluminum alloy-boron fiber composites as a function of temperature and time. Titanium, zirconium or hafnium are used as alloying additives. Also examined is the effect of the simultaneous presence of typical composents of industrial refractory aluminum alloys on the interaction of aluminum and its binary alloys with carbon fibers with silicon, manganese, iron, copper, nickel, magnesium and zinc as additives. Magnesium, zinc, iron and copper retard the interaction with carbon fiber and the first two improve wettability and the last two do not. References 16: 7 Russian, 9 Western.
[124-7872]

UDC 669-494

ON THE ROLE OF INTERFACES OF FIBER COMPOSITE COMPONENTS ON STATIC STRENGTH IN AXIAL STRAIN

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 2, 1980
pp 122-127 manuscript received 10 Nov 79

USTINOV, L. M., Moscow

[Abstract] The hypothesis is demonstrated by theoretical analysis, that the strength of a fiber composite, reinforced with chopped brittle fibers, increases as the strength of the interface of the components increases, and after peaking begins to fall to a minimum, remaining constant as the interface strength continues to increase. The minimum is reached at an intermediate interface strength, which depends on the properties of the components. The validity of the basic conclusions of theory is demonstrated by example of rolled or pressed boraluminum. The aluminum-boron fiber composite with chopped boron fiber is represented as a model, consisting of two brittle fiber bundles, surrounded by a matrix. Strain is applied to the entire system, and the interface strength in one bundle is assumed

to be zero, and maximum in the other, and equal to the strength of the matrix. The strength properties of this model are analyzed and results are found to agree satisfactorily with the basic conclusions of theory. Figures 3; references 16: 10 Russian, 6 Western.
[124-7872]

UDC 669-494

STRESS-STRAIN STATE OF MICROFILAMENT-BASE FIBER COMPOSITE

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 2, 1980
pp 116-121 manuscript received 21 Apr 79

CHEBAN, V. G., GORDON, V. A. and BULGARU, O. Ye., Kishinev

[Abstract] The stress-strain state of a metal matrix, reinforced with cast microfilament, is analyzed by a technique developed for composite beams and generalized to the case of a system of parallel reinforcing rods. The microfilament is made by glazing a metal filament, producing a composition with a tri-phase structure. The elastic behavior of the material is analyzed and approximate formulas are derived for determining the elastic and strength properties of the composite as functions of the relative concentration and mechanical properties of all three phases of the composite. The analysis shows that the axial stress in each phase is constant and changes abruptly on boundaries. Vertical and transverse stresses are negligible in comparison with axial stresses, and when the Poisson ratios of all the materials are equal the vertical and transverse stresses vanish, so that all three components of a composite made of an aluminum matrix and glazed steel microfilament under axial strain may be assumed to be in a one-dimension l stress state. References 3: all Russian.
[124-7872]

UDC 669.28+669.296]:548.5

ON THE PRODUCTION OF ANISOTROPIC COMPOSITES BASED ON SYSTEMS INCLUDING A METAL AND A CARBIDE OF A TRANSITION METAL

Moscow IZVESTIYA AKADEMII NAUK SSSR: METALLY in Russian No 2, Mar/Apr 80
pp 187-189 manuscript received 29 Jan 79

SIDOROVA, T. A., KALASHNIKOV, Ye. V., GUTS, Z. A., ANDREYEV, A. A.,
KORKIN, I. V. and SMIRNOV, V. V., Leningrad

[Abstract] An examination is made of the structures of cast alloys in the systems Mo-Mo_2-C, Mo-HfC, Mo-TiC, Mo-ZrC and Zr-ZrC over a range of cooling rates from 50 to 10,000 deg/sec. A study was also done on the

feasibility of producing regular structures in these systems by zone melting. The rate of zone displacement (crystallization rate) was varied from 0.01 to 5 mm/sec. The temperature gradient at the crystallization front was constant at 100 deg/cm. Heating was by a single-coil inductor with inside diameter of 12-16 mm. Power supply to the inductor was from a 60 kW rf oscillator at 220 kHz. The results show that regular structures are produced in the Mo-Mo_2C system with zone crystallization at a rate of 0.10 mm/sec, and in the Mo-TiC system at 0.01 mm/sec. No orienting effect was observed in the other systems. Regular structures are "favored" in cast alloys produced at various crystallization rates with unidirectional crystallization. Figures 1; references 3: 1 Russian, 2 Western.
[126-6610]

UDC 621.791.927.5

KINETICS OF HEATING OF HARDENER GRAINS IN THE METAL POOL DURING HARD FACING OF COMPOSITE ALLOYS

Kiev AVTOMATICHESKAYA SVARKA in Russian No 4, Apr 80 pp 32-35 manuscript received 1 Feb 79; after final revision, 2 Jan 80

YUZVENKO, Yu. A., Doctor of Technical Sciences, BELYY, A. I., engineer, Institute of Electric Welding imeni Ye. O. Paton, Academy of Sciences, UkrSSR

[Abstract] Hard facing of a metal in the welding pool, for the purpose of producing a wear-resistant surface layer, can be made more effective by impregnating the hardener grains to be deposited with a fusible binder alloy and coating them with a protective metal film so as to lower their solubility in the base metal. The feasibility of this depends on the kinetics of the thermal processes in the pool and on the concentration of hardener grains, both factors determining the interaction between the components. The specific example here is a very large pool of molten steel, initially at a high temperature uniform throughout the volume and then cooled while small spherical grains of tungsten carbide with a nickel coating at room temperature are dropped into it. An analysis based on the applicable equation of heat balance and the Fourier equation of heat conduction reveals that, depending on the order in which the melting points of the component substances decrease, the coating can be beneficial inasmuch as it lowers both the peak contact temperature and the solubility of hardener grains. The coating also lowers the maximum safe concentration of hardener grains which, if necessary for improving the wear resistance of the layer, can be raised by other means. Figures 6; references 2: both Russian.
[135-2415]

UDC 529.4

EFFECT OF RESIDUAL STRESSES ON FRACTURE OF BINARY COMPOSITE MATERIALS

L'vov FIZIKO-KHIMICHESKAYA MEKHANIKA MATERIALOV in Russian Vol 16, No 2,
Mar-Apr 80 pp 53-57 manuscript received 28 Feb 77

MALAFEYEV, A. S., TRU H, I. I. and BEREZHNITSKIY, L. T., Physico-Mechanical
Institute, Academy of Sciences, UkrSSR, L'vov

[Abstract] A temperature change causes strains in a composite material which are proportional to the thermal expansion coefficients of the component substances. When these strains do not decrease due to plastic flow, then brittle fracture can result. Accordingly, residual stresses must be taken into account in an evaluation of the strength of composite materials with cracks. Here the problem is treated analytically in the case of a composite material consisting of a binder matrix and a reinforcement inclusion. The concentration of inclusion elements is sufficiently low to make interaction between them negligible. The bond of inclusion elements to the matrix is sufficiently strong to make them deform simultaneously with the latter. The physico-mechanical properties of both components are assumed to be independent of the temperature within the range of temperature changes. On this basis calculations are made of the stress distribution in a circular inclusion inside an infinitely large isotropic and elastic plane, with a straight diametrical crack inside the inclusion, under a thermal load compounded by either uniaxial transverse or equibiaxial orthogonal tension. Analogous calculations are made for the case of a crack extending into the binder matrix. The results indicate a local effect of inclusion elements, of almost the same magnitude under uniaxial and biaxial tension. Depending on whether $(\alpha_{mt} - \alpha_{it}) \Delta t$ is positive or negative (α_{mt}, α_{it} denoting the coefficients of linear thermal expansion of the matrix material and the inclusion respectively, Δt denoting the temperature change), residual stresses will correspondingly increase or decrease the strength of the composite. Figures 1; references 6: 5 Russian and 1 Western.
[132-2415]

UDC 621,793

USE OF COMPOSITE CERAMIC-ALUMINUM/NICKEL POWDERS FOR COATINGS

Kiev POROSHKOVAYA METALLURGIYA in Russian No 11, Nov 79 pp 24-28
manuscript received 26 Dec 78

NOVIKOV, N. N., PUSTOTINA, S. R., SOLOV'YEV, B. M., PISKAREVA, N. M. and TOLOK, V. K., Odessa Technological Institute of the Food Industry

[Abstract] A new composite material has been proposed for spraying on ceramic substrates of alumina or zirconia so as to ensure adequate chemical interaction and, as a result, a high bond strength of such coatings on metallic articles. Particles of this material consisting of aluminum and nickel are deposited with a plasma (Ar:Ne = 1:1) jet and then quenched in water to form a double-layer shell. With the nickel layer underneath, a smooth coating film is formed on a wettable oxide surface. With the aluminum layer underneath, its continuity is broken up by nickel dispersing in it, and an agglomerate structure of droplets with high surface tension is formed. In either case, according to x-ray phase analysis with a DRON-0.5 diffractometer and a CuK source, the most complete formation of the Ni_3Al intermetallic compound and maximum utilization of the exothermic effect are achieved with an Al:Ni = 1:3 powder mixture. The bond strength of such 0,1-0,2-mm-thick coatings was found to reach 300-400 kgf/cm^2, and to reach 500 kgf/cm^2 with a chemically deposited nickel undercoating. The porosity was lower in Al_2O_3+Al+Ni than in Al_2O_3+Ni+Al coatings. Figures 3; references 7: all Russian.
[75-2415]

UDC 620.171.5:621.822.5:669.018.95

STRESS DISTRIBUTION IN COMPOSITE ANTIFRICTION MATERIALS

Kiev POROSHKOVAYA METALLURGIYA in Russian No 11, Nov 79 pp 54-59
manuscript received 6 Dec 78

ZABOLOTNYY, L. V., Institute of Problems of Material Science, Academy of Sciences, UkrSSR

[Abstract] An optical polarization method has been developed at the Institute of Problems of Material Science jointly with the Chair of Elasticity Theory at the Kiev State University imeni T. G. Shevchenko for analyzing the stress distribution in structurally anisotropic materials. This method, using a GMV-57 photoelastimeter (made in Czechoslovakia), was employed in a study of an antifriction compound consisting of epoxy resin and polyamide (100:140 or 100:150). This compound was heated to 70° C, deaerated at this temperature for 5 min, and then poured into a

mold together with inclusions of a high-elasticity polymer. The mold consisted of metal plates with an organosilicon fluid coating. Isochrome patterns under variously applied loads, correlated with measurements of principal stresses in models containing single inclusions only, indicate that a spheroidal or ellipsoidal shape of inclusions yields the optimum stress distribution under any load. Wear-resistant solid inclusions with a diameter larger than that of the contact area are safer, carrying a much smaller load than the matrix, and an adequately wide spacing of such inclusions improves the fatigue strength of the composite material. Figures 5; references 5: all Russian.
[75-2415]

UDC 539.3:678.5.06

DYNAMICS OF FLIGHT VEHICLE COMPONENTS MADE OF COMPOSITE MATERIALS

Riga MEKHANIKA KOMPOZITNYKH MATERIALOV in Russian No 6, 1979
pp 1042-1047 manuscript received 17 May 79

VOL'MIR, A. S., and DEDIK, Ye. V., Moscow

[Abstract] The dynamic characteristics of intricately shaped airfoils made of composite materials are investigated. The airfoils are simulated with an orthotropic plate of variable rigidity. The finite-difference method is applied on satisfying varied boundary conditions by introducing the concept of the plate of zero rigidity and mass. The problem of determining the frequencies and forms of intrinsic vibrations is solved with the aid of a computer. The effect of the wing aspect ratio, and the mass and rigidity distribution on the dynamic characteristics of the composite-material airfoil is investigated. The convergence of the method was verified for a model problem--the case of a triangular isotropic plate of fixed thickness. For practical calculations a grid with 30-40 nodes is sufficient. Figures 4; references 6: 3 Russian, 3 Western.
[80-1386]

UDC 620.173:678.067.5

FEATURES OF THE COMPRESSIVE TESTING OF COMPOSITE MATERIALS

Riga MEKHANIKA KOMPOZITNYKH MATERIALOV in Russian No 6, 1979 pp 1111-1118
manuscript received 7 May 79

ZHIGUN, I. G., POLYAKOV, V. A. and MIKHAYLOV, V. V., Riga, Institute of Mechanics of Polymers, Latvian SSR Academy of Sciences

[Abstract] Normally, reliable information on the compressive strength of composites is difficult to obtain owing to the high degree of anisotropy of their elastic characteristics and to their low shear strength. Hence a broad variety of techniques of the compressive testing of composites is employed, resulting in a broad scatter of experimental findings. In this connection, three different techniques of compressive loading of specimens are analyzed: normal loading of the principal surfaces; normal and tangential loading of lateral surfaces; and combined normal loading of frontal surfaces and normal and tangential loading of lateral surfaces. On the basis of an analysis of stress distribution in the specimens, the first of these techniques is found to be deficient in view of the high stress concentrations at the lateral surfaces. The parameters of specimens are selected according to the conditions of their stability until the exhaustion of loadbearing strength. The effect of loading method and dimensions of the specimen on its compressive strength in compressive testing of carbon- and boron-plastics is investigated. Recommendations for selecting the shape and dimensions of specimens of modern composite materials with the object of determining stable values of their strength are presented. Figures 3; references 10: 5 Russian, 5 Western.
[80-1386]

UDC 536.2:678.5.06

ANALYSIS OF THE THERMAL RESISTANCE OF COMPOSITE STRUCTURAL ELEMENTS MADE OF HEAT INSULATING MATERIALS

Riga MEKHANIKA KOMPOZITNYKH MATERIALOV in Russian No 6, 1979 pp 1048-1053
manuscript received 26 Mar 79

ZARICHNYAK, Yu. P. and MURATOVE, B. L., Leningrad Institute of Precision Mechanics and Optics

[Abstract] A method for computing the thermal resistance of heat-insulating wall panels made of composite materials is presented. Panels with honeycomb and corrugated types of partitions are considered. The method is based on the analysis of the temperature field in structural elements with heat flux directed at right angles to the panel's plane. The

transport of thermal energy across the composite wall owing to thermal conductivity, radiation, and convection is considered. Formulas for estimating the effective thermal conductivity of discrete panel cells are derived. The theoretical findings are compared with experimental data on panels of various geometry in the presence of temperatures ranging from -40 to 90° C, and it is shown that the proposed formulas and models make it possible to design composite panels with desired heat insulating characteristics. It is also shown that structural elements made of composites reinforced in various ways with glass plastics are extremely promising as materials for developing lightweight structures for various purposes. Figures 7; references 6: all Russian.
[80-1386]

CORROSION

EFFORTS TO REDUCE CORROSION THROUGH THE USE OF PROTECTIVE COATINGS

Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian No 70, 25 Mar 80 p 2

[Article by S. Buknarin, Special Correspondent, Slavyansk-Zhdanov-Moscow]

[Text] A discussion about engineering, which can help to solve one of the most urgent problems--reducing the losses of ferrous rolled products--can start from the statements of scientists. Academician Ya. M. KOLOTYRKIN said: "Direct losses due to corrosion amount to approximately 13-14 billion rubles per year. But direct losses are only a part of the total losses and are not the main cause." Academician B. Ye. PATON stated: "In a year, as the result of corrosion, we lose 15 million tons of steel. A gigantic metallurgical combine works only on rust." Academician A. I. TSELIKOV added: "If we are to further prevent disruption in the production of rolling and protect rolled products from corrosion, rust must be halted or it will consume even more. Rolled products should be protected immediately as it comes from the metallurgical combines and plants. Today we have an adequate technical stockpile in order to furnish protective coatings over a wide industrial base. This is primarily related to sheet rolling, in which the branches of machine building and the construction industry are testing for a large need."

The scientific and technical stockpile, about which Academician A. I. TSELIKOV, Director of VNII metmash [All-Union Scientific Research Institute of Metallurgical Machine Building] talked, can be seen in the city of Slavyansk in the Donetsk Oblast. Here, several years ago, an affiliate of VNIImetmash developed protective coating units for all forms of ferrous rolled products. For instance, take steel strip and wire. At the experimental plant of the affiliate the coworkers displayed a working model of a future industrial unit where during a continuous process the strip and wire undergo electrolytic etching, are cleaned and then treated on the electrolytic tinning or chromium plating units. The finished product is then suitable for shipment.

Even now new units are developed in miniature and their working processes are adjusted and presented to the designers, who can then proceed to design industrial engineering samples. But what can these units do? The Moscow

Serp i Molot Plant has been put into operation a line for applying a protective coating to thin steel strip, and the Zhdanov Metallurgical Plant imeni Il'ich has installed a tendem AGTs-2U unit for hot zinc plating thin cold-rolled sheet which works wonderfully. True, the units operating at the Zhdanov Metallurgical Plant are still not the last word in engineering. While 200-240 grams of zinc are used per square meter of rolling stock in the hot method of applying a coating, the electrolytic zinc plating process requires only one-fifth the amount of zinc for the same area.

If we can say that protected metal lasts several times longer than unprotected metal, then the introduction of this new engineering at ferrous metal enterprises will yield an economic effect to the national economy the extent of which would be difficult to estimate. It was not by accident then that in the approved programs of the State Committee USSR for Science and Technology (SCST) the development and industrial introduction of protective coating units is being provided to the branches.

What of the directors of the Ministry of Ferrous Metallurgy USSR? Did they seize the developed methods and begin to widely introduce the new technology at enterprises?

The unit for hot zinc and aluminum plating, the AGTsA-1700, according to the SCST plan should have begun producing in 1978. Associates of the affiliate of VNIImetmash completed technical design of the unit but it won't go into mass production until 1981, 1982 or 1983 and the end of the transfer period can't be seen on the horizon. The same fate overtook the AGTs-2000 unit, a complex of continuous units for electrolytic zinc plating, a unit for electrolytic tinning of sheet and chromium plating of sheet and units for lead plating strip and polymer coatings. A powerful unit for electrolytic zinc plating, the ATETs-2000, is scheduled to be put into operation in 1985 at the Karaganda Metallurgical Combine. The investigation and checking of operating modes of this unit must be started this year but the deal has been frozen because the Karaganda Combine refused to award a contract for equipment design.

"Such cases are not unique in our practice," says V. I. DUNAYEVSKIY, Director of the institute affiliate. We created a good technical stockpile for production of domestic units for protective coatings, but they are not being put into industry.

The same Slavyansk affiliate of VNIImetmash, by the order of the Ministry of Ferrous Metallurgy, together with the Dnepropetrovsk Institute of Ferrous Metallurgy, carried out plans for reconstruction of the 2500 and 1700 cold rolling mills for the Magnitogorsk Combine and the Cherepovets and Zhdanov Metallurgical Plants. A new method for rolling large rolls was the basis of the designs. On the merits of the designs it can be said that the productivity of the 2500 mill would rise by 62.5% and that of the 1700--by 80%. The equipment can almost be placed in existing areas. This overequipping will provide a rise in production by 2.6 million tons per year, which is equivalent to the introduction of the cold rolling mill built at the Novolipets Metallurgical Plant. However, the Ministry of Ferrous Metallurgy preferred to freeze these designs and units for protective coatings.

Our country has achieved the greatest position in the world in the smelting of iron and steel and the processing of rolled shapes. Rolled sheet production is even greater. And at the same time, when labor has already been expended in the mining of ore and production of metal for the three first conversions, we cannot rationally use the production, since too much of it is disappearing irrevocably to corrosion. It approaches the fourth conversion. Where is the logic?

We will offer a word to the chief of the technical administration of the Ministry of Ferrous Metallurgy USSR, V. V. LEMPITSKIY: "the fourth conversion is the Achilles' heel of our branch."

And then the appearance of this "heel" was explained. No, the lack of capital expenditures is not the reason for the lag in the fourth conversion. For each five-year plan ferrous metallurgy received capital for its development, but it was applied to the same production which gave rise to the growth of smelted and rolled tons of metal. That is to say, to perceptibly improve the operating indicators of the branch enterprises. For example, hot rolling mills. They are cheaper "cold" mills, and the labor expenditures are less on them. What sense was there for the plants and combines to introduce expensive equipment which only reprocessed the already rolled metal? And to order more protective coating units from the machine builders? In fact this was just another indication to start into the conversion of finished production and to lower the indicators by not producing payments in tons from capital expenditures.

Indeed, is this the logic as the result of which millions of tons of rolled products and pipe rust? It is possible, for the sake of "their" indicators, that the government interests were relegated to the background?

Not without interest is the opinion of the Deputy Chief of the Division for Heavy Transportation and Highway Construction Machine Building of Gosplan USSR, I. S. Reves. He explained that the capacities of plants under the Ministry of Heavy Machine Building are from year to year encumbered only with the manufacture of equipment for the three first conversions of producing protective coating units. It is necessary, finally to develop a specialized machine building base for the fourth conversion, but there are no capital expenditures available. For example, in Slavyansk, construction of an experimental plant for the affiliate of VNIImetmash has begun and reconstruction of the Slavyansk Heavy Machine Building Plant is proceeding. Both projects are situated next to each other and could be used as that specialized base for producing protective coating units. However, the work here was delayed excessively due to the fact that it is weakly financed. Gosplan is not releasing capital. Two of its divisions, found under one roof, could solve the problem, transfer a portion of the capital for creating a base and organize production of domestic engineering for the fourth conversion. But no, the two divisions cannot find a common language.

"Machine builders do not know how to make good protective coating units" says A. F. MINAYEV, Chief of Gosplan's Ferrous Metallurgy Division.

The conviction, being softly spoken is invalid.

We can be proud of the fact that our country takes first place in the production of steel and rolled products. But it is absurd if millions of tons of this production are consumed by ordinary corrosion, causing a billion losses annually. Development of ferrous metallurgy requires a qualitative change. It is not possible to forget comrade L. I. BREZHNEV's statement at the 25th Congress of the CPSU: "...in the final analysis it is not steel but parts made from it that are needed by the consumer. And he receives them only when there is a wide assortment of rolled products of the proper quality of metal..."
[123-6368]

6368
CSO: 1842

UDC 620.197.3

CORROSION WEAR OF ShKh15 STEEL IN AQUEOUS SOLUTIONS OF POLYETHYLENE GLYCOL AND GLYCEROL WITH INORGANIC INHIBITORS

Moscow ZASHCHITA METALLOV in Russian Vol 16, No 2, Mar/Apr 80 pp 137-140
manuscript received 18 Jun 79

TOLSTAYA, M. A., KROPACHEV, V. S. and SHILOVSKAYA, M. YE., Central Scientific Research Institute of Ferrous Metallurgy

[Abstract] The corrosion-electrochemical behavior of unquenched ShKh15 steel was studied under friction conditions in nonflammable hydraulic fluids (polyethylene glycol and glycerol in water) in the presence of inorganic inhibitors. The study showed that oxo anions $Cr_2O_7^{2-}$, HPO_4^{2-} and NO_2^- have a considerable effect on corrosion wear of ShKh15 steel in polyethylene glycol and glycerol. Bichromates (chromates) and phosphates in combination with some organic inhibitors can be recommended for suppressing the corrosive action of these fluids. The organic additives extend the protective range of the inorganic inhibitors. Soviet-produced salts of chromic and phosphoric acids are inexpensive and readily available. Figures 3; references 9: 8 Russian and 1 Western.
[128-6610]

UDC 620.193

CORROSION OF ALUMINUM ALLOYS IN THE BLACK SEA AT VARIOUS DEPTHS

Moscow ZASHCHITA METALLOV in Russian Vol 16, No 2, Mar/Apr 80 pp 156-158
manuscript received 15 Dec 78

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[Abstract] Six aluminum alloys were tested for corrosion at depths ranging from 7 to 80 m in the Black Sea. Test duration was 21 months. The rate of corrosion increases from 0.0031-0.0033 $g/m^2 \cdot hr$ at a depth of 7 m to 0.0046-0.0057 $g/m^2 \cdot hr$ at 80 m, with losses as high as 0.0067 $g/m^2 \cdot hr$ in isolated instances. An analysis of hydrophysical and hydrochemical data for the test region and the results of laboratory tests made it possible to rule out depth variations of oxygen concentration, pH, temperature and flowrate as factors leading to the depth behavior of aluminum corrosion. The main factor was shown to be the variation in silicic acid concentration, which increases with depth due to decreasing photosynthetic activity. Figures 1; references 9: all Russian.
[128-6610]

UDC 620.193.01

INVESTIGATION OF THE MECHANISM OF CORROSION CRACKING OF TITANIUM ALLOYS

Moscow ZASHCHITA METALLOV in Russian Vol 16, No 2, Mar/Apr 80 pp 120-125
manuscript received 31 Jul 78

MARICHEV, V. A., ROZENFEL'D, I. L. and LUNIN, V. V., Academy of Sciences USSR, Institute of Physical Chemistry

[Abstract] A study was done on the influence of cathodic polarization to -1.3V on the growth rate of a crack in corrosion cracking of titanuum alloys at room temperature. Specimens of VT3-1, VT5, VT15, VT4 and VT20 were studied in solutions of NaCl and NaF, and also with delayed destruction in air. The technique used for determining the mechanism of cracking corrosion involved studying the influence of cathodic polarization on crack growth as a function of the initial rate of growth at the corrosion potential. This approach was developed previously for high-strength steel. Titanium alloys typically show a combination of two fundamentally different mechanisms of subcritical crack growth: one produces crack growth as the metal interacts with the corrosive medium (the mechanism of corrosion cracking), and the other acts in the absence of a corrosive medium. The principal mechanism of corrosion cracking of alloys of VT4, VT3-1, VT20 and VT15 in a solution of NaCl, and VT3-1 in a solution of NaF, is anodic dissolution of the metal at the tip of the crack. In this case, crack growth can be considerably delayed or totally stopped by cathodic polarization. The principal mechanism of cracking corrosion of VT4 alloy in a solution of NaF is hydrogen embrittlement in which cathodic polarization accelerates crack growth. Figures 3; references 15: 2 Russian, 13 Western.
[128-6610]

UDC 620.193.4

CORROSION BEHAVIOR OF AD1-V SHEET COMPOSITE IN VARIOUS MEDIA

Moscow ZASHCHITA METALLOV in Russian Vol 16, No 2, Mar/Apr 80 pp 126-132
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TOLSTAYA, M. A., MANUYLOV, V. F., GRYUNVAL'D, M. P., MUKHINA, M. G. and KEMKHADZE, V. S., Moscow Aviation Technological Institute

[Abstract] A corrosion-electrochemical study was made of the Soviet AD1-V boroaluminum composite produced by hot rolling. Corrosive media were selected to simulate flight conditions of aircraft components: air at 100% relative humidity, tap water, a 3% solution of sea water with 0.1% H_2O_2 added, and a 3% solution of NaCl acidified to a pH of 4 by HCl.

It was found that the AD1-V composite with a volumetric fraction of boron fiber of 20 and 25% can be considered corrosion-resistant under subtropical humid conditions close to the sea. Slight damage was observed under these conditions on AD1-V (30%), but the material was not destroyed after a year of holding under these conditions. AD1-V can be considered completely stable in rain or river water, especially when the ends of sheets are protected. Sea water is agressive to this material, even when only the flat side of the boroaluminum sheet is contacted, and corrosion resistance drops sharply with increasing boron fiber content. In peeling corrosion, the major factor is the action of galvanic cells formed by the AD1 aluminum matrix and the boron fibers. Contact current is appreciable and persistent only when the aluminum matrix is active in chloride-enriched media. A reduction of pH activates the aluminum and intensifies peeling corrosion. Subsurface corrosion develops due to deep pitting and bubbling of the foil layers in chloride-enriched media. Figures 4; references 10: 7 Russian, 3 Western.
[128-6610]

UDC 620.193

INVESTIGATION OF HYDROGENATION AND STABILITY OF TITANIUM WITH CATHODIC POLARIZATION IN A SODIUM CHLORIDE SOLUTION

Moscow ZASHCHITA METALLOV in Russian Vol 16, No 2, Mar/Apr 80 pp 113-119
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TOMASHOV, N. D., MODESTOVA, V. N., YAKUBENKO, A. R., YEVTUSHENKO, I. V., VLASOVA, YE. S., BAGAYEV, S. P., IL'IN, M. I. and BORISOVA, YE. A.

[Abstract] The stability, hydrogenation and mechanism of destruction of VT1-0 titanium specimens were studied at a cathodic current density of 3000 A/m^2 in a solution of 0.5 n. sodium chloride. The studies were done on hot-rolled bar stock, forged, stamped and rolled bars, hot-rolled pipe, hot-rolled annealed sheet and forged castings. A relation was found between metal structure and corrosion resistance. It was found that destruction of the hydride layer is by brittle laminar fracture. The outer layer of electrolytically formed hydride has the composition of TiH_2. The high internal stresses that destroy this layer are due to the different specific volumes of the hydride and titanium. Titanium becomes more resistant to cathodic corrosion as grain size decreases and metal structure becomes more perfect with elimination of martensite structure, improvement of grain uniformity, reduction in the number of twins and elimination of special orientation. No clear relation could be established between corrosion resistance of titanium and impurity content. Cathodic hydrogenation of titanium is considerably reduced by oxidizing the titanium in the solution with periodic interruption of the current. Figures 4; references 9: 4 Russian, 5 Western.
[128-6610]

UDC 620.178.3+620.18

RESISTANCE TO THERMAL FATIGUE OF HEAT RESISTANT ALLOYS WITH PROTECTIVE COATING

Kiev PROBLEMY PROCHNOSTI in Russian No 4, Apr 80 pp 59-63 manuscript recieved 7 May 79

BOKSHTEYN, S. Z., BYCHKOV, N. G., DUL'NEV, R. A., ZAYTSEV, G. N., OL'SHANSKAYA, E. YA. and RYBINA, T. V., Central Scientific Research Institute of Aircraft Engine Building imeni P. I. Baranov

[Abstract] Blades of gas turbines are calorized for protection against corrosion and erosion in a gas stream in an atomsphere of combustion products. However, such a coating also reduces the plasticity of the surface layer and has been found to reduce, under sufficiently high static loads, the fatigue resistance of ZhS6KP heat resistant steel under cyclic thermomechanical loads. A study was made to determine the effect of various coatings on ZhS6U heat resistant steel under a deformation of 0.6-3% and $100 \rightleftarrows 950^\circ$ C temperature cycles with holding for 1.5 min at 950° C. The most effective crack inhibitor under these conditions was the NiCoCrAlY coating (50-80 μm thick) with an $\alpha+\beta$ phase structure. With Ni-15Al-35Cr-Y and CoCrAlY coatings, cracks were found to propagate radially into the base metal and to shorten the life most appreciably. In air at a large deformation ($>0.8\%$) the life of specimens decreased by 30-50% and at a small deformation ($<0.6\%$) after 10^3 cycles the life of specimens remained the same with or without coating. Figures 5; references 8: 3 Russian, 5 Western.
[139-2415]

UDC 620.194

EFFECT OF CHEMICO-THERMAL TREATMENT ON THE RESISTANCE OF WELDED TITANIUM JOINTS IN CORROSIVE MEDIA

L'vov FIZIKO-KHIMICHESKAYA MEKHANIKA MATERIALOV in Russian Vol 16, No 2, Mar-Apr 80 pp 118-119 manuscript received 4 Jun 79

VOVK, S. T., "Khlorvinil" Kaluga Industrial Association

[Abstract] Pure grade VT1-0 titanium is used for equipment in the "Khlorvinil" Kaluga Industrial Association production plants. Its corrosion resistance in aggressive media is one order of magnitude higher than that of structural carbon and stainless steels. Oxidation and molybdenization of welded titanium joints have been found to be completely effective, cementation to be only partially effective, and plating or varnishing to be not effective at all in protecting welded titanium

joints against corrosive wear in kainitic lyes (pH = 4.3, 60-115° C), magnesium-chloride lyes (pH = 2.3-4.8, 65-90° C), hypochlorite solution (40-50° C), and in HCl vapor + $MgCl_2$ aerosol mixtures (pH = 3-4.5, 100° C). References 4: all Russian.
[132-2415]

UKRAINIAN SSR FERROUS METALLURGY INDUSTRY DEVELOPMENT OBJECTIVES NOTED

Kiev EKONOMIKA SOVETSKOY UKRAINY in Russian No 11, Nov 79 pp 3-11

[Article by Ya. Kulikov, Ukrainian SSR minister of ferrous metallurgy and Hero of Socialist Labor: "Major Problems in Development of the Republic's Ferrous Metallurgy Industry"]

[Text] Our country has at its disposal an immense economic potential. It has been achieved primarily on account of the development of the national economy's industries, which have created the means of production, an important place among which is occupied by ferrous metallurgy. Metal is the foundation of industry, one of the most important construction materials. On to which extent the country produces ferrous metals and on their quality and assortment will depend the rate of growth of capacities in all areas of the national economy (especially in machine building and in putting capital investments to work) and, in the end result, the well-being of the Soviet people.

During the years of the Soviet regime, because of the constant attention of the Communist Party and the Soviet government, the country's ferrous metallurgy industry has been subjected to serious reconstruction and renovation. Having at its disposal modern enterprises furnished with first-class equipment, it has become the largest producer of metal. In 1978 in the USSR were smelted 151 million tons of steel. This is almost one fifth of the entire amount of it produced on the planet.

The 25th CPSU Congress confronted toilers in all industries of the national economy, including in ferrous metallurgy, with important tasks with regard to improving production efficiency and work quality. The decree "On the Improvement of Planning and Strengthening the Effect of the Economic Machinery on Improving Production Efficiency and Work Quality," adopted by the CPSU Central Committee and the USSR Council of Ministers, was aimed at implementing the decisions of the 25th Party Congress. The fulfillment of this decree's stipulations will make it possible to improve the system of planning and acccounting and will create favorable conditions for solving the industry's main problem, that of supplying the country's national economy with metal products in the necessary amount and assortment and of high quality.

The ferrous metallurgy industry of the Ukrainian SSR, an integral component of the country's metallurgical industry, will also grow and become stronger. The total production of the most important kinds of products will be increased. During the three years of the 10th Five-Year Plan period the smelting of cast iron increased by 7.9 percent and of steel by 7.1 percent, the production of rolled metal by 1.2 percent and of steel tubes by 1.2 percent and the yield of iron ore by 3.2 percent. In 1978 the Ukraine's ferrous metallurgy industry smelted 56.7 million tons of steel and produced 38 million tons of fabricated rolled steel and six million tons of steel tubes.

At the present time are being produced about 28,000 type sizes of tubes, 90,000 different types of metal products and more than 4000 varieties of hot-rolled and bent rolled metal shapes from 2000 grades of steel.

Because of improvement of the quality and extension of the total output of economical kinds of rolled metal, the savings of ferrous metals in the national economy during the three years of the current five-year plan period equaled about two million tons. Every year in the Ukrainian SSR's ferrous metallurgy industry are carried out about 800 measures relating to the introduction of advanced technology, more than 500 relating to mechanization and more than 300 to the automation of production, about 600 relating to the modernization of existing equipment, and about 60 to the introduction of computer technology. In only three years of the 10th Five-Year Plan period, because of measures relating to the introduction of new equipment in the industry, has been gained a savings to the tune of 174 million rubles and an added profit of 140.9 million rubles, including 116.3 million rubles because of lowering of production costs, and a comparable release of 8600 industrial production personnel has been made possible. Each ruble invested in carrying out measures relating to the introduction of new equipment enables a return of 56.2 kopecks, i.e., capital outlays will be recovered in less than two years. Especially effective is the utilization of capital for the automation of production and the introduction of advanced technology (per one ruble of expenditures the return equals 95.1 and 69.5 kopecks, respectively).

The utilization of metallurgical production waste has been improved--94 percent of blast furnace and 37.7 percent of steel smelting slag are being utilized.

In addition, the vast scale of the economy and the dynamism of its development have occasioned an increase in the demand for metal, as noted at the November 1978 Plenum of the CPSU Central Committee.

Under the current situation, when there has been an ever greater growth in total output, expansion of the assortment of metal products and complication of production and economic relationships at all levels of management, is required the efficient and intelligent utilization of ferrous metallurgy's materials and equipment base and of all our capabilities and resources.

Being developed and refined at the present time are the draft of the new five-year plan for development of the ferrous metallurgy industry for 1981-1985 and an outline for the development of the industry to 1990. An analysis of shortcomings impeding the production of a great amount of metal and improvement of its quality should become the starting point of plans for development of the industry.

At all stages of metallurgical production, beginning with the recovery of iron and manganese ore and refractory materials and ending with the production of finished metal products, it is necessary to carry out an extensive retooling program by means of the reconstruction and modernization of existing enterprises, the entry into service of new large-capacity modern units, the replacement of obsolete equipment and the improvement of technological processes on the basis of a close relationship between science and production.

Here special attention is being paid to the development of science and engineering to make possible an improvement in the technical level of production, an improvement in the quality of metal products, the creation of low-waste and waste-free processes, the fuller involvement in production of byproducts of metallurgical production, and the maximum reduction of harmful discharges into the atmosphere.

The introduction of already existing scientific and experimental design developments, as well as the creation of new techological processes and kinds of products and equipment, should ensure a significant improvement in labor productivity, a lowering of production costs, a savings of material resources and a high level of automation and mechanization of production processes.

In the decisions of the 25th CPSU Congress and the plans of the 10th Five-Year Plan period much attention was paid to improving the quality of metal.

At the October 1976 Plenum of the CPSU Central Committee L.I. Brezhnev said, "Let me give metal as an example. We did not have enough of it when 50 million tons of steel were smelted and we do not have enough now when we have almost three times more of it. To solve this problem only by means of a quantitative growth in production would be both improper and very much to the disadvantage of the national economy. It is precisely for this reason that the qualitative side of the matter, the improvement of the industry's efficiency, has acquired first-level significance. And the potential here is vast."

Representing this potential are a radical change in the structure of steel smelting production by the replacement of open-hearth steel with Bessemer converter and electric-furnace steel, the extensive introduction of continuous casting of steel, the replacement of obsolete rolling, tube and metal products equipment, and the development of the fourth conversion process.

In 1978 the output of Bessemer converter steel increased to 33 percent (as opposed to 30 percent in 1975). Phase one of an electric-furnace steel smelting foundry went into operation at the Donetsk Metallurgical Plant imeni Lenin. More and more extensively are being introduced advanced methods of casting steel with the employment of slide gates instead of stopper gates, and employing heat insulating inserts, as well as the casting of steel with continuous ingot casting machines. The industrial introduction of a method of the out-of-furnace processing of steel with slag and inert gases has begun.

At the republic's ferrous metallurgy enterprises, work on the introduction of comprehensive systems for product quality control has been basically completed. These systems are being used at 91 enterprises in the Ukraine. This has been conducive to an increase in the amount of products with the State Emblem of Quality, the output of which for 1978 equaled 10.7 percent of the total volume of manufactured products (as opposed to 1.5 percent in 1975). Now these products are being produced to the tune of 1.4 billion rubles worth, and by the end of the five-year plan period this figure will exceed two billion rubles per year.

The production of high-quality effective kinds of rolled metal is increasing. In 1978 (as compared with 1975) the output of sheet metal and plates with coatings increased 33.3 percent, of rolled metal with a reduced field of tolerance by 40.1 percent and with hardening heat treatment by 31.6 percent, of curved shapes by 5.2 percent and of shapes made of low-alloy steel by 2.8 percent. The production of 78 hot-rolled and cold-bent rolled metal shapes has been mastered.

In the 11th Five-Year Plan period the republic's ferrous metallurgy industry will be developed along the line of improvement of the structure of ferrous metals and improvement of consumer properties for the purpose of the more efficient utilization of metals in the national economy. New modern Bessemer converter and electric-furnace steel smelting foundries and rolling and tube mills will be built, existing units will be reconstructed and technological processes will be improved. The intent is to master a new high-efficiency process for smelting steel in Bessemer converters with bottom blasting. By the end of the coming five-year plan period the percentage of Bessemer converter steel in terms of the total amount of steel produced will be increased to a great extent. The total output of electric-furnace steel will increase significantly.

Another important direction for improving production efficiency and the utilization of metal is the introduction of the achievements of science and engineering and of new technological processes, as well as further development of the production of effective kinds of metal products. Much attention must be paid to the question of improving the quality and utilization properties of rolled sheet metal, especially thick sheet metal.

Technical progress in metallurgical production will make it possible to achieve a considerable savings of materials and fuel and energy resources. Because of a rise in the temperature for hot blasting, an increase in the use of natural gas and improvement of the technology for blast furnace production, in three years of the 10th Five-Year Plan period the specific consumption of coke in the smelting of cast iron was reduced by 10 kg, which made it possible to save more than 500,000 tons of valuable fuel.

The more efficient employment of blasting with a rise in its temperature and enrichment with oxygen, the maximum substitution of coke with less scarce and expensive solid, liquid and gaseous fuel, and, in the future, the injection of coal dust together with lime, saltpeter, fluorspar and metalized materials, are the major directions of technical progress in blast furnace production.

Hastening of the reconstruction and re-equipment of blast furnaces is envisaged. Measures will be carried out for the radical modernization of air heaters, for improving the durability of charging equipment and for extending the service life of air tuyeres.

Ferrous metallurgy is a highly energy intensive industry. With regard to the consumption of fuel and electric power, about 30 percent of their total consumption in the republic takes place at its enterprises. The structure of the balance of boiler and furnace fuel demonstrates that about 30 percent of the demand for it is covered by internal secondary fuel resources, i.e., blast furnace and coke gases, and the remaining portion is supplied by fuel supplying organizations. During the years of the 10th Five-Year Plan period teams at metallurgical enterprises developed and carried out about 2500 measures for saving fuel and 1500 for saving thermal power, which made it possible to reduce the consumption of conventional fuel by 3.5 tons and of thermal power by 2.8 million Gcal. Specific expenditures of electric power for production have been reduced by almost one percent annually.

Supplying them with coke of the necessary quality has a great influence on the operating results of metallurgical enterprises. The limited nature of the raw materials base for coking byproduct production and the inadequate supply of coking coal of branded composition have complicated the industry's work.

The solution to the problem of fully supplying metallurgical production with coke requires taking measures aimed at renovation of the furnace inventory and altering the coking technology. It is necessary to construct coke oven batteries with a capacity of one million tons of coke each, to use high-temperature refractory materials in the lining and to carry out other effective measures. At the present time at coking byproduct plants there are in use a considerable number of obsolete and worn-out pieces of equipment. Slowing of the pace for renovation of the inventory has taken place because of the insufficiently rapid introduction of new capacities for the production of coke. In 1971-1978 the plan for introduction of these capacities was fulfilled by only 70.6 percent.

Estimates have demonstrated that for the purpose of eliminating the lag in renovation of the fixed capital of coking byproduct plants it is necessary to construct 12 modern coke oven batteries to replace those worn out, which will make it possible to create a reliable base for the advancement of blast furnace production.

The development of mining enterprises is being carried out at a rapid pace. During the three years of the 10th Five-Year Plan period more than 45 percent of all capital investment was earmarked for this subindustry. This made possible a considerable growth in the production of commodity iron ore and iron and manganese ore concentrate. The production of agglomerate and pellets increased by 6.6 percent and reached almost 92 million tons, whereby the output of pellets--the best raw material for blast furnaces--grew by more than one third. Nevertheless, the demand for metallurgical raw material is still not being satisfied totally. The percentage of agglomerate and pellets in the iron ore burden of blast furnace foundries has been increasing extremely slowly and in individual years a reduction in this indicator has been observed.

A considerable lag has been occurring in the entry into service of production capacities for the recovery and preparation of iron ore for smelting. In addition, the mining and geological conditions for the recovery of ore have been steadily worsening, and this has resulted in an increase in the expenditure of capital and materials. All this has caused the need to solve a number of large problems, in particular, with regard to the thorough mastery of mineral resources and the development of new technological processes conducive to a considerable increase in labor productivity.

Plans have been made to solve the problem of expanding the raw materials base of the Krivoy Rog Basin by involving magnetite quartzites in underground exploitation followed by their concentration.

Developing and stoping systems will be introduced, making it possible to carry out operations on a single horizontal level and to mechanize to the maximum all key and ancillary processes. Methods of accomplishing upsets without the presence of people will become widespread and self-propelled mining machinery and vibrating equipment will find an application.

The efficient and thorough utilization of mineral resources and the improvement of the efficiency of mining operations in the open-pit exploitation of iron ore deposits are to be achieved by the further use of the continuous-cycle technology and of large-capacity excavators and by the introduction of effective methods of opening pits.

In mining ore both by the underground and open pit method will be employed the technology for crushing rock by the effect of an explosion, which will make it possible to obtain ore with a specific granulometric structure.

In addition, for the purpose of increasing production capacities for the mining of iron ore, such problems will be solved as arrangements for repeated exploitation of lost high-grade ore (at the present time exploitation is being carried out at a depth of not greater than 1000 m), a shift to the concentration of shaft-mining ore with an iron content of up to 38 to 40 percent, and the thorough extraction of iron from the tailings of GOK [mining and concentration combine] concentration plants.

It is planned to develop manganese ore enterprises by involving in exploitation carbonaceous ore and low-capacity strata. The Bol'she-Tokmakskoye Deposit will be put into service. For manganese ore mines is being developed a new technology based on the extensive application of mechanized complexes, new methods of executing and reinforcing mine workings and the creation of totally mechanized mines with continuous production, which will make possible the thorough utilization of natural resources and a 1.5- to twofold increase in labor productivity.

In agglomerate production, for the purpose of improving the quality of agglomerate and increasing its output, are being planned the reconstruction of existing and the entry into service of new sinter plants, and the solution of problems relating to blending raw material and improving the technology for agglomeration, cooling, crushing and multistage sorting of agglomerate.

At existing sinter plants it is planned to increase the height of the layer of the charge to be caked to 350 to 400 mm and the consumption of lime to 60 to 80 kg per ton of agglomerate and to install crushers for the purpose of crushing hot and cold agglomerate to a fineness of not greater than 50 mm and mechanical sieves with a sifting efficiency of not lower than 80 to 90 percent for a grain size of 5 to 6 mm, and to make possible cooling of the entire agglomerate.

The accomplishment of a combination of measures will make it possible to bring the percentage of prepared iron ore raw material in the burden of blast furnaces up to 99.7 percent with an iron content of up to 62.6 percent, and to reduce to six to nine percent the content of the 0 to 5 mm fines fraction.

It is also necessary to carry out a combination of investigations and studies on the creation and mastery of new and the improvement of existing methods of pelletizing ore and concentrates.

Of great importance in improving the operating figures of the industry is supplying production with prepared metal scrap. Each ton of scrap in steel smelting production replaces a ton of cast iron. Furthermore, water consumption and harmful discharges into the atmosphere are reduced considerably. Consequently, the better that ferrous metallurgy enterprises are furnished with scrap metal, the less expensive rolled metal is for the country.

Unfortunately, in recent years rates of growth in the procurement of scrap have been reduced in spite of the fact that with an increase in the smelting of metal the retiring portion of the country's fixed metal assets has been steadily increasing. Coordinated actions are required from planning agencies, ministries and departments in taking measures of an organizational nature and in developing and using reliable key economic factors and incentives in order to interest enterprises and organizations in a caring attitude toward the collection, storage and surrender of metal scrap.

A decisive factor in improving production efficiency is retooling and the reconstruction and modernization of equipment. In the republic's ferrous metallurgy industry more than 1.2 billion rubles or 42 percent of all capital investment are spent for these purposes.

Fixed production assets for the Ukrainian SSR Minchermet [Ministry of Ferrous Metallurgy] increased 18.7 percent during the years of the 10th Five-Year Plan. During this period at the industry's enterprises were put into service a number of new units (blast furnace No 1 at the Kommunarsk and electric furnace No 1 at the Donetsk Metallurgical Plant, coke oven battery No 8 at the Avdeyevka Coking Byproduct Plant, the Bessemer converter foundry at the Zhdanovsk "Azovstal'" Plant, the caking plant at the Dneprovskiy Mining and Concentration Combine, etc.), considerable capital investments have been made for the reconstruction and modernization of existing units and equipment (coke oven batteries at the Krivoy Rog and Makeyevka coking byproduct plants, a tube electric welding shop at the Novomoskovsk Tube Plant, steel smelting foundries at the Makeyevka imeni Kirov, Yenakiyeva, Kommunarsk and Krivoy Rog "Krivorozhstal'" imeni Lenin metallurgical plants), and money has been spent for improving product quality, work safety and protection of the environment.

This has been conducive to an improvement in the utilization of intensive production factors. In 1978 (as compared with 1975) for the industry as a whole the KIPO [useful volume utilization factor] of blast furnaces increased by three percent, the pressure beneath the throat by six percent, and the consumption of oxygen for the production of cast iron increased by 25.7 m^3/ton, or by 36 percent. In steel smelting production the yield of steel from one square meter of the area of a furnace's hearth increased by 7.3 percent. The mean hourly output of rolling and tube rolling mills increased.

The intensification of intensive production factors, as well as the existence in operation of a considerable number of worn-out inventory items, especially in coking byproduct, tube, metal article and refractory material production processes, aggravated the problem of maintaining equipment in working condition.

As statistics demonstrate, expenses for the maintenance and repair of equipment, buildings and structures make up more than 11 percent of the total cost of production. The amount of repair work increases annually. In 1978 at the ministry's enterprises it amounted to 1.2 billion rubles worth. Expenses for capital and routine repairs exceed the industry's total capital investment.

The problem of improving the effectiveness of repair operations requires speeding the development of the repairs base for enterprises as compared with the growth in the cost of production assets in key shops. Furthermore, special attention must be paid to radical improvement of furnishing of the industry's repair shops.

The problem of repairs requires a comprehensive solution. Joint efforts are required on the part of metallurgists and the USSR Gosplan and Gossnab.

Steady attention in the ferrous metallurgy industry is being paid to the level of mechanization and automation of processes of labor and production. During the three years of the five-year plan period it increased by 2.8 percent and reached 48.2 percent in 1978. The rate of the mechanization of manual operations in the ferrous metallurgy industry for 1976-1978 was two times higher than in the years of the Ninth Five-Year Plan.

In 1978 at the industry's enterprises were introduced 16,070 inventions and efficiency suggestions aimed at the mechanization of manual labor and the automation of production processes. An additional savings to the tune of 16 million rubles was gained.

In evaluating the state of mechanization of the inventory as a whole, it can be said that almost all key technological processes have been mechanized, but in the performance of ancillary operations manual labor is still employed to a considerable extent.

In recent times the Ukrainian SSR Ministry of Ferrous Metallurgy took a number of measures relating to strengthening and creating new mechanization and automation services at all enterprises.

A major role has been assigned to industrial laboratories for mechanization and automation. Industrial TsLAM's [central laboratories for automation and mechanization] in tube rolling and metal article production have already shown their positive side. By utilizing their experience and for purposes of enabling the extensive introduction of mechanization and automation equipment at metallurgical enterprises has been created the Base

Central Laboratory for Mechanization and Automation of Metallurgical Production. An industrial TsLAM will be created for coking byproduct production.

At the Krivoy Rog Scientific Research Ore Mining Institute has been created a specialized section for introducing its scientific developments in underground operations, including mechanization equipment; the experimental plant of DonNIIchermet [Donetsk Scientific Research Institute of Ferrous Metallurgy] has been expanded.

A further increase in total output and the intensification of metallurgical processes are inextricably linked with solving the problem of protecting the environment from pollution.

The objectives set by the party and government with regard to solving the problem of the protection and intelligent utilization of natural resources in our country have made it possible to determine guidelines and a technical policy in the area of reducing and totally eliminating harmful discharges in metallurgical production.

For the purpose of ensuring the cleanliness of air and water basins in regions of the location of metallurgical enterprises, behind key technological units dust and gas trapping facilities have been built and obsolete and worn-out equipment of existing decontamination facilities is being reconstructed. At coking byproduct plants modern methods are being extensively introduced for reducing discharges in extinguishing coke and loading coke ovens with a charge.

A combination of measures has been developed and is being carried out for completely stopping the discharge of effluents into the basins of the Black Sea and Sea of Azov.

Able to serve as an example of the intelligent utilization of natural resources is the accomplishment of the "Krivoy Rog Basin Mine Water Diversion" plan, by which has been made possible discontinuation of the discharge of highly mineralized mine water into the Ingulets River and the employment of it in a technology for concentrating raw iron ore.

The diminution and later the total elimination of the negative effect on the environment of metallurgical production waste has necessitated ever-increasing expenditures. A great number of decontamination facilities are being put into service every year at the republic's ferrous metallurgy enterprises. Already now in operation are more than 100 large gas and water decontamination units and recycling water supply systems. Considerable capital investment in the construction of environmental protection projects has made it possible to bring the percentage of recycling water supply systems in the industry up to 81.2 percent. Twenty-five enterprises have been converted to complete recycling of water. During the three years of the current five-year plan period more than 15 million tons of harmful substances were trapped or decontaminated from smoke gases discharged into the atmosphere, and 2125 hectares of land destroyed by mining operations have been reclaimed, and 1626 of them have been handed over for the needs of the national economy. In addition, 222 hectares of poorly productive land have been improved by covering it with chernozem.

On the other hand, great expenditures for environmental protection in the ferrous metallurgy industry result as a rule in lowering of the cost-accounting-basis operating results of enterprises. At many enterprises the cost of decontamination facilities reaches a third of the cost of fixed production capital, and in a number of cases reaches 40 to 50 percent, which entails a lowering of output-capital ratio figures. The existing system of the commensuration of expenses and profits is not conducive to an economic interest of enterprises in reducing the amount of production waste.

In solving the problem of offering material incentives for the environmental protection activities of enterprises, it is also necessary to take into account such indicators as extension of the service life of buildings and facilities, the reduction of losses of work time and payments of social insurance benefits in connection with reducing the sickness rate among the population, improvement of the ecological status of public reservoirs, improvement of the yield of agricultural crops and the productivity of stock breeding, improvement of the status of timber assets, and the preservation of architectural and artistic monuments.

In the problem of improving production efficiency an important place has been assigned to a growth in labor productivity.

In 1976-1978 labor productivity in the ferrous metallurgy industry increased by 4.6 percent with an increase in the total gross product of 4.7 percent. Thirty-six thousand people were released for other work (on a mean annual basis).

The chief source of the growth in labor productivity in the industry has been improvement in the furnishing of production with equipment, as well as work steadily conducted at enterprises with regard to introducing the scientific organization of labor.

The percentage of the increase in labor productivity with existing units in terms of the total increase in labor productivity for metallurgical plants has been systematically increasing and has equaled 57 percent in 1961-1965, 67.8 percent in 1966-1970 and 76.2 percent in 1971-1975.

Qualitative changes have also occurred in factors under the influence of which an increase in labor productivity has been gained with existing units. Whereas in 1961-1965 on account of the intensification of technological processes an increase in labor productivity of 9.1 percent was gained and of 10.7 percent in 1966-1970, in 1971-1975 it equaled only 6.2 percent. The same situation has occurred in the current five-year plan period also. This is associated primarily with the fact that in 1960-1971 began to be used such methods for the intensification of metallurgical processes as increasing the blasting temperature and the pressure of the gas under the throat, the utilization of natural gas and oxygen, an increase in the capacity of open-hearth furnaces, etc. Furthermore, in the initial period the employment of these methods of intensifying production does not require considerable capital investment. For further intensification is required radical reconstruction of units and foundries.

The urgent nature of the problem of improving the furnishing of units and foundries with equipment involves not only improving production efficiency, but also the negative balance which has been created at the present time in the work force in the Pridneprovsk and Donetsk regions.

Therefore, in addition to improvement of the equipping of key production processes, much attention must also be paid to the retooling of ancillary services and, primarily, of the repair and transportation services of enterprises.

According to rough estimates, the extensive employment of industrial methods of repair will reduce the idle time of units associated with repair by 20 to 25 percent.

The objective of improving production efficiency requires improving the level of utilization of production assets. For the industry as a whole the output-capital ratio in 1978 (as compared with 1975) was reduced by 11.5 percent.

The lowering of the output-capital ratio in the ferrous metallurgy industry has taken place under the influence of a number of factors. Among these, primarily, are the increased cost of construction and equipment, the natural factor, structural changes, an increase in expenditures for improving the quality of metal products and protecting the environment, as well as the incomplete entry into service of a number of projects.

The rise in the cost of equipment and building and installation work and the extended periods for mastering production capacities have resulted in the fact that for newly introduced projects the output-capital ratio is 1.5- to twofold lower than for similar existing foundries and units. However, in addition to factors lowering the output-capital ratio, factors are also at work which have hindered its reduction. These are, primarily, the improvement in the utilization of existing equipment, the improvement of the structure of capital investment and fixed capital, and the timely execution of industrial engineering measures aimed at speeding the entry into service of the planned capacities of new foundries and units.

Much attention is being paid in the industry to the improvement of socialist competition. More than 94 percent of workers are involved in different forms of labor rivalry.

In the current five-year plan period a great deal is being done to solve the important problem of how to improve the working conditions and everyday life of metallurgists.

The ministry's enterprises have obtained annually an average of 500,000 to 600,000 square meters of housing and have at their disposal preschool institutions to accommodate almost 85,000, 76,700 seats in dining rooms and snack bars, 232 dormitories, 186 sports facilities, 13 sports and health camps and 73 hospitals and polyclinics. Every year more than 60,000 workers and office personnel of the industry rest in sanitoriums, boarding houses and other health centers. In plans for the development of the industry are noted extensive measures for further improving the working conditions and daily life of workers.

Improvement of the management structure and the concentration of production, as emphasized in the decisions of the 24th and 25th CPSU congresses, is a highly important problem, the solution of which will ensure a further improvement in production efficiency.

A general management system has been introduced in the industry. It has been implemented chiefly according to a three-component system: the USSR Ministry of Ferrous Metallurgy, the Ukrainian SSR Ministry of Ferrous Metallurgy, and the production association (combine). Here one management level of the middle component has been abolished, the number of enterprises and organizations, shops and sections has been reduced, and the number of management apparatus personnel has been reduced by 26,000 people with a wage fund of greater than 38 million rubles.

Now in operation in the industry are 28 production associations and combines, responsible for one third of the products produced by the industry.

Aspects of labor in the ore mining subindustry, as well as its great importance in enabling an even pace in the work of metallurgical enterprises, necessitated the creation of the "Ukrruda" republic industrial association of ore mining enterprises, which is made up of 26 enterprises and organizations.

Functioning in the republic's ferrous metallurgy industry are an industrial ASU [automated control system] and, linked to it, 10 automated systems for controlling enterprises, as well as about 80 automated systems for controlling technological processes. These systems are solving problems relating to planning, reporting and monitoring, analysis, operations management, etc.

In the 10th Five-Year Plan period the major trend in the automation of production processes was the creation of process organization (integrated) control systems utilizing standard planning decisions at base enterprises.

The effectiveness of the production operations of the industry's enterprises has increased substantially in connection with the introduction of these control systems, on account of the better and more efficient interaction of units and shops in the modern production process.

Work on the creation and extensive introduction of integrated systems will remain an important trend in future years, too. Furthermore, further development will be given to group multiple-user computer centers (KVTs's) for the purpose of involving in automated control all enterprises of the industry which do not presently have their own computer centers.

The solution of interrelated problems at enterprises, KVTs's and GIVTs's [main computing and data processing centers] of the Ukrainian SSR Ministry of Ferrous Metallurgy will make it possible to carry out overall planning and control in the ferrous metallurgy industry at the republic level and to form an appropriate base for the further introduction of integrated control systems in the industry.

Major objectives in the job of further improving control have been placed before ministries, associations, enterprises and organizations by the decree of the CPSU Central Committee and USSR Council of Ministers "On the Improvement of Planning and Strengthening the Effect of the Economic Machinery on Improving Production Efficiency and Work Quality." The Ukrainian SSR Ministry of Ferrous Metallurgy has prepared a work program for changing enterprises over to the new planning indicators and for evaluating their operations, which will make it possible to ensure maximum results from the industry's work and the strict taking into account of national economic interests.

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CHEREPOVETS BLAST FURNACE CONTROVERSY

Moscow STROITEL'NAYA GAZETA in Russian No 39, 30 Mar 80 p 2

[Article by G. Savel'yev, candidate of technical sciences and senior science staff member of the Central Scientific Research and Experimental Design Institute for the Organization, Mechanization and Technical Assistance of Construction: "What Should a Blast Furnace Be?"]

[Text] The Cherepovets metallurgical plant has exceptionally great significance for the further growth of the country's output of ferrous metals. On the plant's territory is located a second high-output plant with a complete metallurgical cycle: a blast furnace, an oxygen-blown converter and a "2000" mill.

Unfortunately, the development of the second plant began with the "tail end." The first facility to begin production was the last link in the technological chain--the mill. This leads to great non-productive losses. It is sufficient to say that the mill is being fed with imported slabs, each of which costs 14 rubles per ton more than the future Cherepovets slabs which the oxygen-blown converter should produce. However, the construction of the latter has been delayed. Energetic efforts are being undertaken in order to put it into service this year.

Even this long-awaited event, however, will not solve the cardinal problem. Due to a shortage of pig iron only 50 percent of the mill's capacity will be utilized. This, again, means using the expensive imported slabs.

There will be no imported slabs when the new Number 5 blast furnace begins operation. Naturally, it must be built as quickly as possible. The USSR Minchermet has decided that the plant must secure for itself a super-capacity blast furnace of 5580 m^3 capacity. It will undoubtedly possess great advantages over its modest Cherepovets predecessors. A single one of these gigantic blast furnaces would be able to meet the oxygen-blown converter's total requirement for molten iron.

However, we will again recall that the situation is such that the blast furnace must be built at super-high speed. The practice of past years, however, is such that the 5000 m³ capacity blast furnace at the Krivoy Rog plant was erected in 46 months. Apparently, the Cherepovets blast furnace will not be able to make its appearance any earlier than 48 months after the start of construction. The start of construction, however, has not yet been arranged. These are the figures one obtains: over this period of time the "2000" mill should receive 2 million tons of imported slabs annually, while losing about 28 million rubles of profit per year.

The economics of construction do not promise to be profitable, either. For example, the construction costs for one cubic meter of useful volume in the medium-capacity blast furnaces of the Number 4 Karanganda metallurgical combine and the Number 5 Novolipetsk metallurgical plant are equal to 16,000-18,000 rubles, while the same cubic meter at the Cherepovets giant blast furnace costs 41,000 rubles.

It appears that these losses can be avoided if the existing blast furnaces are rebuilt, increasing their capacity, and the Number 5 blast furnace is constructed with a lower volume--3200 m³. This would reduce considerably the losses for the razing and relocation of the existing buildings and structures as well as reduce the operational expenditures associated with consolidating the furnaces. In addition, fewer resources would go into designing, since it is possible to use the designs of similar existing blast furnaces. Finally, the construction time is speeded up by two years.

Naturally, the supporters of this proposal (including specialists at the plant) do not disclaim the super-capacity blast furnaces. However, while it seems that they do have a place at the new metallurgical plants, the expediency of their construction at currently operational enterprises must certainly be based on a consideration of the local conditions. In Cherepovets, as it seems to us, the conditions rule against the giant blast furnace.
[139-9512]

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SHORTCOMINGS IN METAL INDUSTRIES

Moscow EKONOMICHESKAYA GAZETA in Russian No 11, Mar 80 p 2

[Unsigned article: "To Improve the Quality and Utilization of Metal"]

[Text] At present the stock of metal in the USSR is reaching 1.4 billion tons, and every year it is replenished. This is a great resource of the people which must be augmented and preserved and must be rationally utilized in all sectors of production.

Our country has the largest metallurgical complex in the worlo. Its creation is the result of the unremitting concern of the Communist Party for the development of this branch of heavy industry. State capital investments in ferrous metallurgy have constituted around 40 billion rubles just in the last 15 years. Sixteen large blast furnaces, 29 oxygen converters, 40 hot and cold rolling mills, and 30 tube mills have been built, and significant capability has been brought into operation for iron ore output and for production of coke, agglomerates, and pellets. The smelting of steel and output of rolled metal during the period has grown by a factor of about 1.8. In the production of steel our country occupies first place in the world. In the present year, the smelting of steel is scheduled to increase to almost 157 million tons, rolled steel to 109 million tons, and steel pipe to 18.5 million tons.

Factors of Quality

At the present stage of scientific-technical progress, the factor of quality has become a determinant both in metallurgy and in all metal-using industries. The wide introduction of scientific achievements makes it possible to lower metal content significantly and to increase the reliability and durability of hardware in machine building and building structures, and to guarantee by such means a growth in the effectiveness of public production.

Since the beginning of the tenth five-year plan, a large amount of work has been done in ferrous metallurgy on the introduction of progressive engineering and technology. More than 500 new economical types of rolled metal and steel pipe have been assimilated. Owing to the increase in the assortment and rise in quality in the economy, about a million tons of metal are being saved each year.

However, in view of the scale and complexity of the tasks put before the metallurgists by the party and government, the results achieved cannot be recognized as satisfactory. Metal, despite its great volume of production, limits the development of the economy to a certain extent.

The reasons for such a situation, as was noted in a speech at the November (1979) Plenum of the CPSU Central Committee bv Comrade L. I. Brezhnev, are the slow realization of basic qualitative changes in metallurgy itself and a lag in introducing new technological processes into metal-consuming fields of industry. Negligence is tolerated in the storage and utilization of metal. All of this requires decisive measures for technical improvement of production and better itilization of existing systems.

In January and February of the current year, the average daily output of iron, steel, and rolled metal increased significantly in comparison with the same period last year. However, the plan for the two months nevertheless was not entirely fulfilled. There are still some enterprises that lag. Among them are the Nizhniy Tagil Combine and the Yenakievo, Kramatorsk, Dneprovskiy, and a number of other plants where the internal resources are poorly utilized.

It is urgently necessary to assimilate the experience of advanced enterprises. Thus, much attention is being given to the rise in quality at one of the largest enterprises in the country: the Novolipetsk Plant. The metal products made here are receiving practically no complaints. Good reputation is enjoyed by products of the "Elektrostal'" and "Dneprospetsstal'" Plants, which supply metal for the most crucial purposes to machine building, instrument building, and to the automobile, chemical and other branches of industry.

The collectives of the Ashinskiy and Omutninskiy plants and others are fruitfully occupied in improving the quality of metal.

The experience in the modernization of rolling mill equipment on a new technical basis, which results from the creative teamwork of specialists of the Cherepovets Metallurgical Plant and scientists of the All-Union Scientific Research and Planning Design Institute of Metallurgical Machine Building, deserves wide dissemination. Labor productivity of rolling mill personnel has grown 20 percent. The application of new technology has already permitted the saving of 250 thousand tons of metal.

However, in many collectives the struggle for high effectiveness in production and quality of metal is still weakly pursued; new equipment is not assimilated within the designated time periods; technology breaks down; and products are often turned out with deviation from standards and technical specifications. This shows serious shortcomings at the enterprises and insufficient control of their activities on the part of the USSR Ministry of Ferrous Metallurgy.

Improvement in the organization of production, a rise in quality, and a broadening of the assortment of metal products depend largely on hastening the assimilation of new capabilities now being put into practice in the so-called fourth phase, where rolled metal undergoes supplementary treatment and acquires new qualities.

Recently, new capabilities for the chrome-plating of tin plate were put into practice at the Lys'venskiy Metallurgical Plant. This will permit an increase of 10 percent in the country's output of steel sheet metal with anticorrosive covering. It is now up to the metallurgists of the Lys'venskiy Plant to work the new production into plan indices as soon as possible.

No less an important task faces the builders and operational personnel of the carbon-steel cold-rolling shop of the Novolipetsk Metallurgical Plant. This industrial complex is now at the stage of getting ready for production.

Toward Full Capacity

But the assimilation of new capabilities for the output of quality metal is not always and not everywhere organized in the required manner. For the time being, a large new electric steel smelting shop at the Uzbek Metallurgical Plant is working at half-capacity. At the Novokuznetsk Combine in recent years the department for the heat treatment of railroad rails has been rebuilt and expanded. But full output from this undertaking has not yet been achieved. The new equipment has not been introduced into the planned regime of work.

Builders must make their contribution to the struggle for raising the quality of metal. This has to do with the concentration of effort of construction organizations on the decisive objectives of the fourth phase and on shortening of the time period for the introduction of a capability into operation. Meanwhile, the construction of a high-capacity shop for the production of thin tin plate at the Karaganda Metallurgical Combine is being dragged on and on. Lagging construction is continuing even in the current year. The organizations of the USSR Ministry of Construction of Heavy Industry Enterprises and the USSR Ministry of Installation and Special Construction Work together with the Karaganda metallurgists are called upon to increase the tempo of their work significantly.

The basic task of metallurgists is to guarantee fulfillment of the plan for realizing production in terms of realistic indicators and for the whole tasked assortment in accordance with agreements with consumers.

A large role in stimulating work on expanding the assortment and on raising the quality and effective utilization of metal products is being played by the measures for improving the administrative mechanism being implemented according to the decree of the CPSU Central Committee and the USSR Council of Ministers on 12 July 1979. Precisely this must be the subject of special concern of executive managers and party organizations of enterprises. Planning organizations have developed corresponding normative acts. The task of the ministries is to put them into practice in conformance with the conditions in each branch of the economy.

It Concerns Everyone

A conservative attitude toward metal and economical usage are no less a pressing task than are the growth of its production and improvement of quality. For example, the substitution of stamped and welded rolled steel stock and sheet metal for cast products is tied to the technical rearmament of state procurement production in the machine building branches of industry. MeanWhile, cutting remains the basic method of working metal. The progressive processes of stamping, pressing, and upset forging are insufficiently employed. Therefore, the coefficient of metal utilization in machine building remains at 0.72. As a result, up to 8 million tons of metal each year are forced into cutting.

The USSR State Committee for Material and Technical Supply, on its part, is called upon to improve the planning of the burden of orders from rolling mills at metallurgical plants. Too often their specializations are violated.

In a number of instances, a great deal of metal of increased strength is being put into structures according to outdated standards. Such a practice, without any exaggeration, can be called extravagant waste. At the same time, it is also a large potential for economy.

Significant losses are caused by mismanagement in storing and dispensing metal products, and sometimes they are indeed wasteful. This takes place, for example, at "Lidsel'mash" plant in Grodnenskaya Oblast, at the "Krasnyy Aksay" plant in Rostovskaya Oblast, and in the management of "Tatenergostroy." Often, still, rolled metal is not sorted out by type and factory markings, it lies in disorder, and it deteriorates in rain and snow. A location of significant quantities of it is allowed for purposes that are not foreseen by the plan. All of these facts are in conflict with the course being followed for economy and conservation. People's inspectors, the "Komsomol'skiy Prozhektor," and labor collectives are called upon to play an active role in eradicating such deficiencies.

Every labor collective must participate in the massive campaign for economy and conservation in the utilization of metal from production to consumption. Let us even take scrap metal collection. It cannot be looked upon as waste or refuse. It is a valuable secondary raw material. A third of all steel in the country is smelted from scrap metal. The collection and processing of a ton of scrap metal requires a capital investment one twenty-fifth that of smelting a ton of "fresh" cast iron from natural raw materials.

Scrap metal comes from industrial and transportation enterprises, construction, city administration, kolkhozes, and sovkhozes. Taking stock of it and collecting it in many instances are poorly provided for. Improvement in this business depends not only on organizations of "Vtorchermet" [State Trust for the Procurement and Processing of Secondary Ferrous Metals], but also on the managers of every enterprise, on the careful sorting of the scrap and on timely removal by truck and rail transportation.

According to calculations made by scientists, about 10 to 15 million tons of metal each year are carried away, "eaten up," by corrosion. Metal needs to be protected. For this purpose, scientific-research organizations must participate more actively, creating modern methods and means for anticorrosive coverings.

Thus, the front of work for an economical, more rational utilization of metal--a valuable resource of the people--reaches all spheres of labor activity.

Socialist competition is spreading still more broadly for the worthy welcome to the 110th anniversary of V. I. Lenin's birthday and for the successful completion of the tenth five-year plan. The celebrated collective of the Magnitogorsk Combine exhibits forms of a Leninist model of work. Having fulfilled the tasks of four years of the five-year plan with honor, it has committed itself to exceed the 1980 plan in all basic indices, achieving all growth in production through raising labor productivity, assimilating 23 new types of rolled metal, and bringing the share of products with the State Mark of Quality up to 25 percent of the total volume of production. This commitment is being realized and the combine is working steadily and well.

The leaders of competition in all branches of the economy have accepted and are fulfilling their plans and obligations and are achieving economical utilization of material resources and of metal first of all. The wide dissemination of their experience is an important state matter.
[129-9645]

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MAGNETODYNAMIC PUMP FOR AUTOMATIC METAL POURING INTRODUCED

Moscow IZVESTIYA in Russian 15 May 1980 p 2

[Article by IZVESTIYA correspondent S. Tsikora: "Novelty in the Foundry"]

[Text] The profession of foundry hand has always been considered a difficult one. If one just takes such a labor-intensive operation as metal casting. In the foundries of even the most modern plants, both in our country and abroad, the liquid metal is most often cast manually or using a mechanical device repeating these same manual operations. A foundry hand should make many hundreds of ingots during a shift.

These are the working conditions. And now about quality. Metal casting from a ladle is the operation which influences casting quality the most. It is difficult to speak about the stability of the process, the accuracy with which the heating conditions are maintained, the high purity of the alloy when all of these parameters depend significantly on the skills, the attention and the qualifications of the foundry hand.

Science has come to their assistance. Scientists at the Institute of Casting Problems of the UkrSSR Academy of Sciences have created a device which is still unknown in world practice. They called it a magnetodynamic pump, abbreviated as MDP. And this machine was designated for automatic casting of liquid metal.

When the scientists showed their brainchild to production workers for the first time, the workers examined the unheard of machine with interest, but in their hearts they had doubts. Both the simplicity of operation and the universality of the device troubled them. The pump transfered the liquid metal through a pipe as if it were water. The casting form was filled with the metal with the same rapidity, accuracy and facility as a glass is filled with carbonated water from a dispensing machine. Moreover, the liquid metal was transfered under the influence of a magnetic field. The device created by the scientists permitted the use of ladleless methods for casting metals.

This meant a revolution in foundry matters. Manual labor was totally eliminated. The foundry hand could even put on white coveralls and control the electromagnetic field, which performed all necessary operations with the liquid metal, from a control panel.

But the laboratories of an academic institute are not plant foundries. Production workers create the reputation for a machine.

The magnetodynamic pump underwent the most arduous testing in the shops of the "Kievtraktorodetal'" production association. The working conditions here for foundry hands are the same as at other enterprises in the country. Therefore the cases of the association management may be considered typical: chronic lack of workers in the foundries and the endless search for technical innovations for mechanizing heavy and monotonous work. The news about the new item created at the Institute of Casting Problems of the UkrSSR Academy of Sciences was naturally greeted here with interest. But incorporating the pump immediately turned out to be impossible. It could transfer aluminum, zinc and type metal, but not pig iron. And the "Kievtraktorodetal'" foundries work precisely with pig iron, the material most widespread in machine building. The development of a pump design capable of operating with liquid pig iron would represent the solution of the "casting problem" for most of the machine building sectors.

The association management took a technical risk and made certain sacrifices. The risk was a decision to incorporate in their plants a device which had not existed previously. And the sacrifices were in the form of assistance to the Institute's Department of Magnetodynamics, where the new unit was born, with engineers from the plant. The work lasted several years. Today almost two dozen magnetodynamic pumps are in operation in the foundries of the "Kievtraktorodetal'" association, and the foundry hands have become the operators for the new devices.

The specialists of the Institute of Casting Problems of the UkrSSR Academy of Sciences and the association workers were recently awarded the UkrSSR State Prize for development and incorporation of this machine. Other awards merited by various modifications of the unit -- the First Degree Diploma at the "Interlitmash-72" international exhibition, the Gold Medal at the "Aluminum-75" exhibition, and the Gold Medal at the 1977 Leipsig Fair -- preceded this honor.

Properly, the scientific part in the biography of the MDP ends here and a second, no less complex stage, determining the quantity of the new product to be produced, the mass introduction of magnetodynamic pumps at enterprise foundries, begins. For a technical innovation is capable of solving social problems -- increasing productivity and labor quality and improving the working conditions of man -- only when it is widely used.

Until recently, the main source of magnetodynamic pumps was the experimental production of the Institute, and the experimental subdivisions were highly interested in obtaining the new product as quickly as possible for their own shops. Thus the MDP appeared in a number of plants in Moscow, Leningrad, Kiev, Konotop, Ufa and Ust'-Kamenogorsk. But this was only a drop in the sea of demand.

The recently adopted decree of the CPSU Central Committee and the USSR Council of Ministers "On the Significant Elevation of the Technical Level and the Ability of Metalworking, Casting and Woodworking Equipment and Machine Tools to Compete" dotted all the "i's" to the protracted problem of series production of magnetodynamic pumps. Now industrial production of magnetodynamic units for automatic pig iron pouring on a conveyor will be performed by the Pinsk Casting Equipment Plant of the USSR Ministry of Machine-Building and Tool Industry. This means that each newly produced automatic molding line will be equipped with a magnetodynamic installation, and those already in operation will be modernized.

But the technical potential of the idea itself of "controlling" a liquid metal using a magnetic field has far from exhausted itself. The MDP has permitted us to solve only one of the problems, casting pig iron in foundry production. Automation of steel teeming is next in line for investigators. And in the future lies ladleless transport of metals by creating continuously operating units in ferrous metallurgy.
[146-9194]

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UDC 666.3.32

SELECTION OF DRYING-GRANULATION UNITS FOR PRODUCTION OF SPECIAL CERAMIC MOLDING POWDERS

Moscow STEKLO I KERAMIKA in Russian No 4, 1980 pp 18-19

POLYAKOV, A. A., LYKOV, M. V., URTAYEV, A. A., Rybino Aviation Engineering Institute

[Abstract] The two existing methods of calculating drawing-granulation units are considered. The first method is based on the material and thermal balance of the process of spray drying when the volume of the drying chamber required for evaporation of a required amount of moisture at a selected specific mousture content is determined. The second method is based on the principle of calculating the height and diameter of the burner. Counterflow spray dryers for ferrite and thermoresistor materials are calculated. The dimensions of drying chambers required for the investigated materials should be greater than those calculated by the previous methods. The investigations made it possible to select and conduct industrial trials of a drying-granulation unit for production of ferrite and semiconducting thermoresister molding powders and also to calculate the dimensions of drying chambers for ceramics based on aluminum oxide, used in manufacture of dielectric articles. Figures 2.
[147-6521]

UDC 661.66.3

ON THE STRENGTH OF GRAPHITES BASED ON CALCINATED AND UNCALCINATED COKE

Kiev PROBLEMY PROCHNOSTI in Russian No 4, Apr 80 pp 23-26 manuscript received 26 Jul 78

GUSMAN, N. O., CHERNYKH, V. A., CHERNYAVETS, A. N. and BAGROV, G. N., Moscow

[Abstract] Synthetic graphite made from coke forming at approximately 560° C has a much higher mechanical strength than graphite made from coke calcinated at 1200-1300° C. The causes of this difference are analyzed by the method of linear fracture mechanics. Accordingly, data on the dynamic modulus of elasticity and readings of tensile tests are evaluated in terms of toughness. On this basis, with numerical values appropriate for both variations of coke, the tensile strength squared is found to be approximately proportional to the effective toughness and, moreover, graphite from uncalcinated coke is much tougher. This is explained by a higher binder-graphite content and correlated with the grain-size distribution, the strength of a fine fraction increasing with toughness much faster than does the strength of a coarse fraction. Figures 1; references 10: 7 Russian, 3 Western.
[139-2415]

UDC 620.178.16:669.295

GAS-ABRASIVE WEAR RESISTANCE OF AT3 AND AT6 TITANIUM ALLOYS

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian
No 12, 1979 pp 34-36

BORISKINA, N. G., BRYSKIN, A. M., and KENINA, YE. M.

[Abstract] Titanium alloys are used for pipes in deep oil wells where aluminum alloys do not withstand the high-temperature corrosive environment. However, despite their superior mechanical properties in most areas, titanium alloys have inferior wear resistance. Since the corrosive action of the environment has some effect on wear resistance, the authors studied the influence of temperature, mineralization, pH, and rate of corrosion flow on gas-abrasive wear of AT3 and AT6 industrial titanium alloys. The study was based on the method of mathematical planning of experiments. It was found that the determining factors in gas-abrasive wear of these alloys are temperature and the pH of the corrosive solution. Neither mineralization nor the rate of the corrosion flow had any effect on gas-abrasive wear of either alloy. Wear was insignificant in alkaline and neutral media at room temperature. After treatment in acid solutions ($pH < 4$) at high temperatures (250° C) both alloys showed intensive wear. AT3 alloy had higher corrosion and wear resistance that AT6. Both alloys are recommended for making deep-drilling pipes. Figures 2; references 7: all Russian.
[67-6610]

UDC 669.018.27'8'44

PRECIPITATION HARDENING OF Ni-(Co)-Cr-Nb ALLOYS

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian
No 12, 1979 pp 10-12

BARSEG'YAN, L. V., SAMARINA, N. M., and SIDOROVA, I. B., Central Scientific Research Institute of Ferrous Metallurgy imeni I. P. Bardin

[Abstract] To find a basis for developing precipitation-hardened spring alloys with high thermal stability, an investigation was made of the effect of cobalt on precipitation hardening and on the physicomechanical properties of Ni-(Co)-15Cr-10Nb alloys with cobalt content varying from 6.8 to 33.5%. Sheets 0.3 mm thick were made by hot and cold plastic deformation. The kinetics of precipitation hardening was studied from the change in hardness and in the mechanical and elastic properties of the specimens during aging after quenching to the solid solution from 1150° C in water. All alloys showed a pronounced precipitation hardening

effect and high strength and elastic properties with satisfactory relaxation stability at 500° C. Cobalt in amounts of 12.6-21.5% enhanced the precipitation hardening effect and raised the strength and elastic properties. The maximum effect was observed with a cobalt content of 21.5%. The main hardening phase was Ni_3Nb with a bct lattice. Figures 4; references 11: 6 Russian, 5 Western.
[67-6610]

UDC 620.18:620.17:669.725'26

STRUCTURE AND MECHANICAL PROPERTIES OF THE BERYLLIUM-CHROMIUM SYSTEM

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian
No 12, 1979 pp 13-15

MOLCHANOVA, L. V., NAGORSKAYA, N. D., YATSENKO, K. P., MEZHENNYY, V. M. and KOLESNIKOVA, V. I.

[Abstract] Alloys of the Be-Cr system were studied by microstructural, thermal, x-ray, local x-ray spectral and chemical analysis and by measurement of microhardness. Beryllium content varied from 22.5 to 92.8% and chromium content, from 4.3 to 78.0%. It was found that phases crystallize that are based on beryllium and compounds of $CrBe_{12}$ and $CrBe_2$. The composition of $CrBe_{12}$ is apparently very close to the peritectic point on the phase diagram. Eutectic crystalli ation occurred with a content of 13.8% Cr at a temperature of 1240 ± 10° C. Binary alloys of beryllium containing up to 13% Cr had comparatively low strength -- no greater than 10-11.6 kgf/mm^2. When the beryllium-chromium alloy was doped with nickel or vanadium, the strength increased to 14-17 kgf/mm^2. The investigated alloys had low ductility. Figures 4; references 10: 6 Russian, 4 Western. [67-6610]

UDC 621.791.052.08:669.295

WELDING OF THE AT6 TITANIUM ALLOY

Kiev AVTOMATICHESKAYA SVARKA in Russian No 4, Apr 80 pp 56-60 manuscript received 1 Mar 79; after final revision, 10 Apr 79

BLASHCHUK, V. YE., engineer, DZYKOVICH, I. YA., Candidate of Technical Sciences, ONOPRIYENKO, L. M., engineer, Institute of Electric Welding imeni Ye. O. Paton, Academy of Sciences UkrSSR; SHELENKOV, G. M., Candidate of Technical Sciences, Sumy Machinery Manufacturing Association imeni M. V. Frunze

[Abstract] The AT6 corrosion-resistant high-strength titanium alloy (5.5% Al, 0.5% Cr, 0.5% Fe, 0.35% Si) is used, especially in the food industry, for equipment operating at temperatures up to 500° C. An experimental study was made to determine the behavior of joints produced by argon-arc manual welding or automatic welding with electromagnetic stirring. Specimens for this study were cut from hot-rolled 20-mm-thick strip, annealed at 700° C, and welded with a tungsten electrode, manually (PRS-3EMP welder) or automatically ("Neptun" EMP welder) and respectively with or without a filler alloy. A metallographic analysis of the welding seams and mechanical tests of the joints indicated that automatic welding should produce joints 90% as strong as the base metal, and argon-arc manual welding should produce 90% strong joints with the AT3sv alloy as filler or 80% strong joints with the 2V alloys as filler. Electromagnetic stirring enhances the corrosion resistance of these welded joints in citric acid and in tartaric acid. Figures 5; references 6: all Russian. [135-2415]

UDC 621.791.72.011

WELDABILITY OF AK4 HIGH-TEMPERATURE ALUMINUM ALLOY BY ELECTRON BEAM

Kiev AVTOMATICHESKAYA SVARKA in Russian No 1(322), Jan 80 pp 32-33, 45 manuscript received 31 Jan 79, after revision 19 Mar 79

BONDAREV, A. A., Candidate of Technical Sciences, and CHERNOV, V. YU., engineer, Institute of Electric Welding imeni Ye. O. Paton, Academy of Sciences UkrSSR

[Abstract] Grade AK4 alloy of the aluminum-copper-magnesium-iron-nickel-silicon system differs from other aluminum alloys in that it contains no manganese, chromium, zirconium or other elements that produce the press effect. As a result, the alloy is isotropic. The total content of principal dopants (copper and magnesium) in AK4 alloy is 4-5%. The retention of mechanical properties at high temperatures is enhanced by considerable

amounts of weakly soluble or nearly insoluble components -- iron, nickel and silicon. Although the alloy is widely used, it cannot be satisfactorily welded by arc methods. The authors investigated the feasibility of using this alloy in structures made by electron-beam welding. Before the welds were made, the plates were etched in 15% caustic soda at 50° C and brightened in a 30% solution of nitric acid. The welds were tested at 20-360° C on circular specimens with a working section 6 mm in diameter cut across the weld. The specimens were held at the test temperature for 20 minutes. The tensile strength of the welds was found to be higher than that of the plate metal. The impact strength of the welds was on the level of that of the plate metal or somewhat higher at room temperature, but noticeably lower than the impact strength of the plate metal at elevated temperatures. The fatigue strength of aged or quenched and artificially aged welds was found to be close to that of the plate metal. The hardness of the weld metal after heat treatment was somewhat higher than that of the plate metal. Aging alone is not sufficient for restoring the properties of the weld to those of the plate metal. The welds must be quenched and artificially aged. Figures 4; references 4: all Russian.
[94-6610]

UDC 621.791.754'264

INVESTIGATING THE PRESSURE OF THE VAPORS AND GASES WHICH FORM A PROTECTIVE MEDIUM DURING WELDING IN A CARBON DIOXIDE RING

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 3, 1980 pp 9-11

VINOGRADOV, V. S., KUZNETSOV, M. V., Moscow Aviation Technological Institute imeni K. E. Tsiolkovskiy

[Abstract] Electric strain measurement of the pressure of the vapors and gases which form a protective environment in welding with a circular carbon dioxide flux were studied. A special tensometric pressure converter which uses a flat thin membrane with PBK-10-100 strain guage resisters glued to the center, with two each on each side, was developed. The metal membranes manufactured from plates of minimum thickness were tested and were found to be too rigid, and the sensitivity was found to be insufficient to record low pressures. PETF-A metal-coated polyethyleneterephthalate film was selected as the material for the sensing element of the converter. The film has high strength characteristics and lower weight than polytetrafluoroethylene, and the metal-coated surface of the file also has good adhesion when gluing the strain guage resisters. The membrane which was made rigid around the contour of the body was timed by a clamping ring using a threaded ring to eliminate buckling and development of depressions which lead to instability of the converter characteristics. The measurements showed that the vapor and gas pressure inside

the CO2 ring flux increases as the consumption of the shielding gas increases. The excess pressure is not observed when welding with a burner having an enclosing carbon dioxide shield. Figures 5; references 11: all Russian.
[148-6521]

UDC 621.791.01:669.017.3

KINETICS OF TRANSFORMATIONS DURING THE WELDING OF HEAT-HARDENED GRADE 1201 ALUMINUM ALLOY

Kiev AVTOMATICHESKAYA SVARKA in Russian No 1(322), Jan 80 pp 29-31, 39 manuscript received 16 Jun 78

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[Abstract] Grade 1201 alloy of the aluminum-copper-manganese system is hardened by quenching and artificial aging. Natural aging leaves the strength of the alloy practically unaltered. Maximum hardening is realized when the quenched solid solution is aged at 160-180° C. In various stages of the hardening process, Guinier-Preston zones G.P. 1 and G.P. 2 are formed, and the θ'-phase, which is a metastable form of the θ-phase ($CuAl_2$), is precipitated. However, this state of the alloy is unstable. Welding temperatures produce unfavorable changes in the properties of the material both in the seam and in the heat-affected zone. A repeat artificial aging of metal softened by welding partly restores hardness throughout the heat-affected zone, and drops in the hardness curve are shifted toward lower temperatures. The individual stages of the structural transformation that leads to a change in hardness are difficult to observe directly because the section of the investigated zone is small, and the processes take place without demarcation. In this paper the authors study these transformations on specimens of hardened grade 1201 alloy heated under conditions simulating the thermal welding cycle at certain characteristic points of the heat-affected zone. The change in microstructure and hardness of the metal was analyzed as a function of the time-temperature schedule of the experiments. Kinetic diagrams of softening of the alloy are plotted from the results of experiments with heating in a metal bath and cooling at various rates. These diagrams can be used to determine the hardness of the alloy in the heat-affected zone for various welding methods and conditions. Analysis of the influence of temperature on the physical and mechanical properties of grade 1201 alloy in the heat-affected zone must take account of the structural transformations of the age-hardened solid solution of copper and aluminum. Brief heating to temperatures in excess of 350° C partially

returns the alloy to the quenched state, but temperatures below 300° C leave the microstructure and hardness of the alloy nearly unchanged. Figures 5; references 5: all Russian.
[94-6610]

UDC 621.791.01

THERMAL DIFFUSION OF HYDROGEN IN THE WELDING OF TITANIUM

Kiev AVTOMATICHESKAYA SVARKA in Russian No 1(322), Jan 80 pp 20-23
manuscript received 5 Jul 78

ABDULAKH, V. M., SHEVELVE, A. D., engineers, DEMCHENKO, V. F., Candidate of Physical and Mathematical Sciences, and ZAMKOV, V. N., Candidate of Technical Sciences, Institute of Electric Welding imeni Ye. O. Paton, Academy of Sciences UkrSSR

[Abstract] A theoretical analysis is made of the kinetics of development of concentration inhomogeneity of hydrogen in the heat-affected zone during the electron-beam welding of titanium, and the results are compared with experimental data. It is assumed that hydrogen concentration is redistributed solely by thermal diffusion in a direction determined by the negative activation energy of the process of dissolution of hydrogen in titanium. The analysis is based on derivation and numerical solution of a system of two equations: an equation of molecular diffusion with a thermal gradient term, and an equation of heat propagation during welding of a plate by a high-power high-speed linear source. The influence of the liquid phase on mass transfer in the metal is disregarded, and the diffusion equation is solved for the solid phase only. The changes in solubility and diffusion coefficient of hydrogen in connection with the $\beta \rightarrow \alpha$ phase transformation are disregarded, and the redistribution of the gas is considered in the β-titanium. A comparison of theoretical and experimental results shows that the development of inhomogeneity of hydrogen concentration cannot be attributed to thermal diffusion processes alone. Apparently a decisive role is also played by heterodiffusion and the stressed state in the heat-affected zone. Figures 3; references 6: all Russian.
[94-6610]

UDC 621.791.4:539.378.3:669.295

DIFFUSION BONDING OF T-CONNECTIONS OF VT6 TITANIUM ALLOY

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 4, 1980 pp 10-12

LAVROV, B. A., KARAKOZOV, E. S., TERNOVSKIY, A. P., VIGDORCHIK, S. A., PETROSYAN, V. A., REZNICHENKO, G. I. and ROSTKOVSKIY, I. G.

[Abstract] Techniques of the diffusion bonding (DB) of T-connections of VT6 titanium alloy T-beams were investigated on 3-mm-thick sheet specimens measuring 40 x 30 mm in area that had been diffusion bonded in a vacuum chamber ($7\cdot10^{-5}$-$2\cdot10^{-5}$ mm Hg). The optimal DB conditions were found to be: temperature $T = 950^\circ$ C, pressure $P = 0.2$ kg/mm^2, and time $t = 60$ min. Cyclic fracture strength tests and metallographic analysis showed that the principal cause of fracture is the presence of an acute stress concentrator of the form of a notch generated by local deformation of fibers of the material of the T-flange. This concentrator was then eliminated by means of capillary filling with molten metal (solder) as well as through partial melting by means of argon-arc welding. As a result the fracture strength of the joints was increased to 1500 from 140 load cycles. Further experiments, which included the placement of an insert in the joint zone with an object of optimally redistributing the welding pressure, and the cold working of the capillary-filling area, resulted in increasing the fracture strength of the joints to 30,000 cycles ($\sigma_{max} = 42$ kg/mm^2, $\sigma_{min} = 0.15$ kg/mm^2). Figures 5; references 2: 1 Russian, 1 Western.

UDC 621.791.72.01

IMPROVING THE PROPERTIES OF VT20 ALLOY WELDMENTS THROUGH LOCAL ELECTRON-BEAM HEAT TREATMENT

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 4, 1980 pp 7-8

LYSENKOV, YU. T., VLASOV, G. A. and OVCHINNIKOV, V. V.

[Abstract] The effect of local electron-beam annealing on the properties of welded joints of VT20 titanium alloy produced by the electron-beam welding method was investigated. The experiments were performed on 13-mm-thick specimens of annealed sheet (200 x 100 mm in area each) that had been butt-welded with the aid of the ELU-5 electron beam rig. The resulting weldments were, following their cooling to 25° C, subjected to local heat treatment (annealing at 750-800° C for 3-40 min) by means of an unfocused electron beam moving along the joint. The degree of defocusing and the current intensity of the beam were so selected as to avert fusion of the joint. Subsequent tests revealed that, compared with weldments not subjected to such heat treatment (impact strength 45% of that of the base material), the heat-treated weldments display an impact strength roughly equal to that of the base material. Moreover, impact strength is still further increased (to 6.2-7.1 $kg \cdot m/cm^2$) when the locally heat treated weldments are subjected to the so-called "cosmetic operation" consisting in melting the joint of one-third of its depth with the aid of an unfocused electron beam, which results in the formation of a fine-grained structure of the joint. References 6: 5 Russian, 1 Western. [130-1386]

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UDC 621.791.72:669.293.5+669.14.018.8

UNFOCUSED ELECTRON BEAM WELDING OF NIOBIUM ALLOYS TO STAINLESS STEEL

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 4, 1980 pp 14-15

KRUTOGOLOVOV, N. P., D'YACHENKO, V. V., SIVOV, YE. N., FROLOV, N. G. and MONAKOV, A. M., Moscow Aviation Technological Institute imeni K. E. Tsiolkovsky

[Abstract] If niobium alloys are to be joined to stainless steel without the formation of intermetallic compounds, the temperature of niobium in the zone of contact with stainless steel should be 1400-1480° C, with the time of contact being a function of the volume of material and area of contact. This can be assured by unfocused electron beam welding with a low accelerating voltage (8-12 kv). Proceeding from this premise, VN2AE and ELN1 niobium alloys were welded to 12Kh18N10T stainless steel to obtain welded joints 2 to 5 mm thick. The optimal formation of the joint was achieved when the heating spot was 10-12 mm in diameter. The distribution of the components of steel and niobium in the fusion zone was found to be constant and to correspond to the eutectic composition (in %): 10-12 Nb, 9-10 Ni, 15 Cr, 64 Fe. The strength of the resulting weldments at room temperature was found to be a function of the strength of the niobium alloy used. Figures 3; references 3: all Russsan. [130-1386]

UDC 621.791.72:621.373.826

LASER BEAM WELDING OF VNZh7-3 ALLOY TO VT1-0 TITANIUM

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 4, 1980 pp 3-4

BARANOV, M. S., VOSHCHINSKIY, M. L., FEDOROV, P. M., SHILOV, I. F. and ZYTNER, G. D.

[Abstract] In view of the difference in properties between VNZh7-3 sintered alloy (90% W, 6.8-7.4% Ni and 3-3.4% Fe) and VT1-0 titanium (99.2% Ti), it is not feasible to weld them together by any heat source requiring prolonged heating. On the other hand, welding techniques serving to assure a high thermal energy density within a small volume of metal over a brief period of time are suitable for this purpsoe. In this connection, the applicability of argon-shielded laser-beam welding was investigated. The experiments were performed on plane specimens (5.0 x 0.5 mm in area) with the aid of a DVANT-10 laser. In view of the smaller depth of fusion and weld-spot diameter that could be achieved in VNZh7-3 alloy compared with VT1-0 titanium, it was decided to shift the laser beam in the direction of the base metal 0.12 mm away from the joint-line, thus assuring a symmetrical weld spot, and a balanced depth of fusion. The edge joints of VNZh7-3 alloy and VT1-0 titanium proved to have a satisfactory shear strength (32.7-40.1 kg/mm^2). The strength of the weldment exceeded the strength of VT1-0 titanium alone, owing to the formation, in the welded joint, of a new alloy containing components from VNZh7-3 alloy. Figures 5; references 2: both Russian.
[130-1386]

EXCESSIVE CONSUMPTION OF METAL

Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian No 95, 25 Apr 80 p 1

[Article by V. Selyunin, economics reviewer of "Sotsialisticheskaya Industriya"]

[Text] The basic directions for developing the national economy in the years 1976--1980 were to assure a savings in rolled steel used for machine building and metal working of 14--16 percent. Judging from preliminary data for the four years, the outcome is satisfactory enough. If we consider the current plan we can also make a conclusion for the five-year plan as a whole: the real savings will be close to the upper limit designated by the 25th CPSU Congress, that is, 16 percent.

I shall mention one case in particular: mechanical engineers achieve this success under conditions which are more complex than was assumed. For achieving economies in rolled steel products depends not only on those who use it. There was a plan to save 5--6 million tons throughout the national economy in 1980 by improving the quality and expanding the varieties of metals available. This result should have been first revealed in machine building. However, it turned out otherwise. The metallurgy industry is slowly reorganizing for the production of economical shapes. About 80--95 percent of the requests for their manufacture are fulfilled. Of 140 effective rolled products, which should be produced for the needs of the machine building industry, more than one-half have not yet been produced. On the whole, savings due to improved metal quality is only about 60 percent of the amount assigned by the five-year plan.

Of cource, in such conditions it was difficult for the designers to reduce the weight of machines. But nevertheless their achievements were not insignificnt. For the years 1971--1978 the unit metal consumption for turbines and locomotives was reduced by 20--30 percent, for automobiles it was 16.5--20 percent, for power trains, metallurgical installations and diesels, it was 15--17 percent, and for tractors it was 9.5 percent. But the consumption of metal for many kinds of machines is greater in the Soviet Union than in the USA. Bridge cranes, automobiles, forging and stamping equipment, excavators, locomotives, and refrigeration units, in particular, are greater consumers of metal.

The main reason for this lag is inferiority of the grades, and the inadequate strength of the rolled product. For when the needed grade is not available a larger piece is used. Thus, such irrational replacements have used up more than 550,000 tons of rolled products in only 3 years.

As the hopes for reorganizing metallurgy were not completely carried out, it became necessary to search for other resources. About 80 percent of the entire savings in rolled products will be obtained in the five-year plan by improvements in production technology and machine designs. These areas will ensure compensation for overexpenditure caused by the lack of the required kinds of metals and in the final analysis will allow us to introduce one of the most important parts of the 10th Five-Year Plan.

It is relevant to explain at this point how a savings can disappear. The consumption of materials for the annual program is determined in practice according to the norms of the preceding year. Resources are not given out in the full amount, but with some reduction--this will be the program based on a savings. At first glance an executive has nowhere to turn--he is obligated to establish new, more strict rates of consumption and adhere to them; otherwise he has no way to fulfill his responsibilities in production. But here in front of me is a preliminary report from the past year. Enterprises of USSR Minenergo [Ministry of Power and Electrification], according to the plan, were supposed to fulfill their program while using 10,000 tons less of rolled products than would have been necessary for putting out the same amount of gross according to the consumption norms of 1978. According to the report the savings amounted to 12,700 tons. Excellent? Not entirely. If we compare the report not with the norm, but with the actual expenditure for 1978, we discover: for each unit of goods produced, the industry consumed on the average more metal in the year earlier and as a result it required 5,400 tons more in order to fulfill the program. Where then, one might ask, is the savings? It exists only in the report and in reality resources were used more extravagantly than a year ago.

The reason for this deception, I suppose, is understandable: the norms for 1978, which were taken as the base for the future, were much increased, they were easily covered up at the right time, and then it was possible to increase the unit consumption of metal without fear--the report shows a savings all the same.

How typical is such a situation? I examined data for 28 branches of the industry--the savings in 1979 for 18 of them as against the actual unit consumption achieved in the preceding year, turned out to be less than against the norms, and in 5 branches the unit consumptions were even greater. Of course, it would be better to make assignments for the branches and enterprises in the form of a reduction in the unit consumption of resources in comparison with the actual achievements. Unfortunately, this is impossible--at the moment next year's actual unit consumption is in the galley-proof stage, and is still unknown, and it won't be known until much later; the planners must use as their reference unreliable existing norms. In other words, flaws in the accepted index of savings in the annual planning are not easy to get rid of.

However, they are quite noticeable in evaluating the five-year plan of the branches. We shall compare 2 branches--heavy machine building and machine tool manufacture. The former will lower the current unit consumption of rolled products per unit of goods as against the base norms for 1975 by 13.7 percent, and the latter will reduce it by 19.4 percent. Which one is more successful? It would seem that the figures speak for themselves. In actuality, among 11 leading machine building branches of Mintyazhmash [Ministry of Heavy Machine Building] the reduction in rolled product consomption was the most modest, but in Minstankoprom [Ministry of Machine Tool Manufacture] there was almost a record reduction.

However, it is easy to realize that the result depends greatly on how rigid the norms were in the 1975 base year--for the branches which use metal extravagantly at that time, it would be easier to show high rates of savings. Is there an indicator which will balance out the starting difference? I think there is. This would be the coefficient of metal use. In heavy machine building it is currently 0.79--that is, 79 percent of the metal goes into the final product and the remainder into waste products. With such an estimate Minyazhmash is going from next-to-last to first position among the leading branches of machine building--the amounts of waste here are least. On the other hand, Minstankoprom is dropping from a high second position to last--in its enterprises only 61 percent of the metal now ends up in the final product.

The coefficient of metal use more objectively reflects the true picture. On what basis is such a judgement made? Specialists of the state supply inspection board for checking the use of material resources are constantly monitoring the situation in the branches. After having studied their reports for several years, I attempted to compare them to statistical accounts. And almost always it turned out in the following manner: whoever had the greatest statistical savings as against consumption norms, that one was found to have greatest extravagance. However, it was worthwhile to combine the results of inspections with the coefficients of metal use, which put everything in their proper positions: where the coefficient is lower, there greater reserves were found.

This was no accident: the coefficient detects the savings factors, which depend basically on the producers themselves, and not the external circumstances or on the agility of those who make the standards. Beginning in 1980 this indicator will be included in the state plan. Currently it is being raised in the machine building branches from 0.728 to 0.735 and is approaching the USA level (there it is 0.75). The possibilities it holds are enormous. We shall examine several reserves.

In the automobile industry the coefficient of metal use is much lower than the average level and it even fell from that level in the decade from 0.7 to 0.68. What's the matter? The administrative staff of the branch has not lowered the consumption norms for a number of articles for several years, and in general they don't regulate them at all. Thus, for five basic models of "Gaz" trucks, of which more than one-half million tons of rolled products are consumed yearly, Minavtoprom [Ministry of the Automobile Industry] did not approve the norms. Taking advantage of this, the association "AvtoGAZ" increased them in comparison with what had been achieved. And it did no good to add postscripts. For example, the VPO "Soyuzpodshipnik", increasing its reference norms by backdating, showed 1,752 tons of additional savings in its report. Yet for the year 1978 alone the postscript showed an overall savings for the branch of 33,200 tons--it was only because of the vigilance of the inspectors that this figure was excluded from the state report.

The inspectors also detected large reserves of technological capacity. The branch plan section, which oversees the introduction of low-waste technologies, is non-specific. In the best case it provides only 15 percent of the planned economy of metal (on the average for machine building this area adds only 40% of the entire savings). The Gor'kiy Automobile Plant similarly loses metal as waste products, even though it does so on a technically legal basis. One-half of all forged and stamped pieces are manufactured here with impossible tolerances--up to 75 percent of the metal ends up as waste products. During the production of parts by the cutting method in mechanical shops up to 50,000 tons of rolled products annually are turned into shavings.

Perhaps other methods of machining cannot be used? This is not so. Imported cold-forging automatic devices are less than half loaded at the plant. And this is not all. At the Ural Automobile Plant such automatic devices are utilized to only 15 percent capacity and one of them has been standing idle for three years. The new forging installation of UAZ [Ural Automobile Plant], which is rigged with advanced equipment, is operating at half-capacity.

For three years machine building enterprises which are lagging behind have consumed 824,000 tons of rolled products above their norms--these losses were covered by a savings due to the efforts of economical enterprises, and the overall result turned out to be satisfactory. But the total amount of losses of almost 250,000 tons were the "contribution" of Minavtoprom. The automobile engineers, together with enterprises of Minsel'khozmash [Ministry of Agricultural Machine Construction] overconsumed more than 450,000 tons, that is, much more than all other machine building enterprises.

The coefficient of metal use is also falling at Minenergomash, which again is not explained by the obsolescence of production technology. Even by such an obsolescent method as free forging one and half times more intermediate products are manufactured in the branch and this is the average for machine building, but the amount of hot stamping here is only one-fifth. As a result, they consume 96 kilograms of metal more here per ton of forged and stamped products. Suppliers of the enterprises have been able to establish consumption norms which exceed the level achieved so far. For example, the Taganrog "Krasnyy kotel'shchik" received more than 5,000 tons of surplus metal in one year. The warehouses are bursting from the unnecessary abundance. The Khar'kov Turbine Plant has accumulated 11 times more large-diameter tubing than it needs, and the Belgorod Power Machine Building Plant has accumulated 61 times the norm of sheet stainless steel after many years of operation. Cases have been found where high-grade products that haven't been used for a long time at plants of Minenergomash do not show up in the state report--they are not counted among the assets, but they are in the warehouse.

Some plants are profiting by such goings on. The Khar'kov Turbine Plant turns into scrap metal sheet waste products with lengths up to one and a half meters and widths up to 71 centimeters. Metal has become its means of exchange: enterprises exchange it even for vacation resort passes, and, for example, the Izhorskiy Plant paid for the lease on a gymnasium with rolled products. Inspectors pointed out such facts several years ago. What has been done about it at the ministry? Now there is twice as much rolled steel goods at these plants as was detected during the previous inspection.

Sometimes such deceptive practices are committed under pressure from local authorities. The chairman of Kemerovskiy Urban Council G. Veselov "taxed" enterprises in the city for goods produced by them: he made them set aside metal for a fence around a park. An example of bad taste. But hundreds of tons of rolled product were already wasted. Sharpened spikes 3 meters high, forged vignettes, ornaments--evidently in Kemerov they've decided to "reweave" the outstanding lattice work of Leningrad Summer Home. You must be aware of this.

the current year a large increase in production of ready-made rolled steel products is not foreseen, even though it is needed--we are already in first place in the world for output of these rolled steel products. If we are also to become the most economical in the world, then problems of metal shortage will have to be removed from the agenda.
[140-9424]

9424
CSO: 1842

THE FUNCTIONS OF IGNEOUS MATTER

Moscow IZVESTIYA in Russian No 107, 7 May 1980 p 3

[Article by Academician B. Kadomtsev]

[Text] Plasma is familiar to everyone from the brightly glowing lights of modern advertising displays. The stars and the galaxy consist of plasma--ionized gas. Many scientific collectives are laboring persistently on study of the fine physical processes taking place in plasma. Because of this, plasma is finding ever broader fields of use in modern scientific research and production processes. Here are are only a few examples.

The technique of plasma coating of metal products with corrosion-resistant or strong and wear-resistant protective films, developed at the Scientific Production Association Tulachermet under the supervision of Corresponding Member of the USSR Academy of Sciences A. Manokhin, made plasmatrons a desired production participant in modern shops of the metal-working industry. And the technique of applying wear-resistant coatings, which permits a several-fold increase of the operating life of metal-cutting tools and machine parts, was developed at the Khar'kov Physicotechnical Institute under the supervision of Corresponding Member of the Ukrainian SSR Academy of Sciences V. Toloka. The "Bulat" installations developed at this institute have achieved wide introduction in the machine tool and other sectors of the country's national economy.

The new step in study of the underlying principles of plasma physics was begun by research in controlled thermonuclear fusion. The main problem of this research is to produce a plasma at a temperature of tens of millions of degrees and to hold it in this state for a time sufficient for thermonuclear reactions to occur. The principles of the processes occurring in a plasma had to be studied in more detail and a number of methods had to be tested to achieve this goal. Not all attempts were successful, but they considerably enriched our knowledge and some of them revealed new possibilities for solving practical problems.

Specifically, while conducting exploratory research on controlled thermonuclear fusion at the Institute of Atomic Energy imeni I. V. Kurchatov,

N. Filippov and colleagues discovered a new, unusual type of powerful electric discharge at the end of the 1960s, which they called a plasma focus. The discharge occurs in a special cylindrical copper chamber. An insulator on whose inner side is attached an anode, while the cathode is the chamber itself, was installed in the same chamber. A plasma envelope, which is then rapidly compressed by a magnetic field, working off in its path all gas, usually deuterium, is generated upon discharge of capacitor banks near the insulator walls. A very dense plasma bunch is generated as a result of the rapid compression of the plasma near the anode.

This bunch exists for only one 10-millionth of a second, but it manages to emit a very large number of thermonuclear neutrons at 15-30 million degrees during this time. The plasma focus, as a very powerful short-pulse neutron source, began to find various applications in modern scientific research. It was shown in subsequent experiments that the plasma focus in specific modes becomes a powerful X-ray source.

Small chambers to create a plasma focus using compact power supply systems were developed in this direction under the supervision of V. Chernyshev and N. Makeyev. These devices are beginning to find various applications in technology and scientific research, for oil prospecting, development of integrated microcircuits in electronics and in medical and biological research.

So-called plasma beam discharges were investigated in detail during study of the instabilities and collective phenomena in a plasma in a magnetic field. It turned out that these discharges make it possible to develop new plasma production processes.

As was proven by Doctor of Physicomathematical Sciences A. Ivanov and colleagues, a plasma beam discharge can be used to create plasma formations similar to a wide band. This band is formed by the shape of the electric beam shot from an electron gun along a magnetic field in a low-pressure chamber. The electron gun is similar to those used in ordinary television sets, but the cathode in it is made in the form of an elongated thread rather than in the form of a point. The plasma with electron temperature of 20,000-40,000 degrees, formed due to the effect of the beam, is very convenient for conducting plasma-chemical reactions when a wide gas flow passes through the plasma band. The area of the band may reach tens of square decimeters. It can be rolled into a cylinder if the cathode is made in the shape of a ring. In this case the gas can be admitted inside the cylinder, gathering the reaction byproducts beyond its limits. Band discharges may find wide application for creation of plasma-chemical production processes and plasma technology for the electronics industry.

Stationary plasma sources, developed by Doctor of Physicomathematical Sciences A. Morozov and colleagues, may also be used for various production processes. These devices were initially developed as low-thrust space plasma engines. Externally, this engine looks like a cylinder several centimeters in diameter. A plasma jet travelling at a speed of tens of kilometers per second is generated in it. The jet has low density and can be used for "soft" treatment of materials--cleaning the surfaces of impurities, etching, polishing and precision machining of surfaces.

It is difficult to relate all the possibilities of using plasma physics in modern production processes in a brief story. It is important to emphasize that many practical applications occur from purely fundamental research. [136-6521]

6521
CSO: 1842

CONCERNING THE PROBLEM OF THE MECHANISM OF HARDENING OF A MATERIAL UNDER THE ACTION OF A CONTINUOUS LASER BEAM

Kishinev ELEKTRONNAYA OBRABOTKA MATERIALOV in Russian No 1(91), 1980 pp 35-39

KOVALENKO, V. S., Kiev, ENAMI, K., ARATA, YE. and NENNO, S., Osaka, Japan

[Abstract] The paper gives the results of electron microcopes studies of the structure of aluminum specimens exposed to continuous laser radiation. A CO_2 continuous-wave laser emitting with power of 1.5 kW on a wavelength of 10.6 μm was the source of radiation. The laser beam was focused on the specimen by a zinc selenide lens. The workpiece was displaced at rates from 100 to 10,000 mm/min. To prevent melting or vaporization of the workpiece, the specimen was moved away from the focal plane by an experimentally determined distance. Measurements of microhardness showed that the heat-affected zone is made up of three regions in which hardness is usually different from that of the base material. The main zone located beyond the visible track of laser treatment has a very high average hardness of 39.5 kgf/mm^2, that reaches 44.5 kgf/mm^2 in some regions. Between this region and the visible laser track is a very narrow region where the hardness is even lower than in the base metal (30.8 kgf/mm^2, and even as low as 28.2 kgf/mm^2). The third region is within the limits of the visible track, where the hardness ranges from 32.5 to 36.5 kgf/mm^2. Electron microscope analysis shows that the microstructure also differs in these three regions. The hardest region has a dislocation structure, the softest is a dislocation-free region of dynamic recovery, and the intermediate region in the visible track shows dislocation loops with lower density than in the hardest region. The distribution of dislocations is attributed to shock wave motion. Figures 3, references 16: 1 Russian, 9 Western.
[127-6610]

UDC 539.4

RESULTS OF HEAT CYCLING LIFE TESTS PERFORMED ON HEAT RESISTANT MATERIALS UNDER ASYMMETRIC THERMOMECHANICAL LOADS

Kiev PROBLEMY PROCHNOSTI in Russian No 4, Apr 80 pp 49-53 manuscript received 12 Jun 79

LOZITSKIY, L. P., VETROV, A. I. and KOVESHNIKOV, N.A., Kiev Institute of Civil Aviation Engineers, Kiev

[Abstract] A study was made to determine the life characteristics of heat resistant alloy steels (ZhS6K, ZhS6U, EI437B, EP99vd, Kh18N10) under compound static and cyclic thermomechanical loads. Standard specimens

were tested with zero, variable, or constant static load at several levels ranging from 50 to 450 MPa and with cyclic temperature swings ranging from 100-750° C to 350-1000° C. A statistical analysis of the results reveals a log normal distribution of the number of cycles till fracture and a linear dependence of this number (Log N) on the stress. A further mathematical analysis leads to a fourth-degree equation in log N which involves all parameters and with which the median life can be calculated. Figures 4; references 4: all Russian.
[139-2415]

UDC 620.178.3:539.43

ON THE PROBABILISTIC-STATISTICAL PROCESSING OF FATIGUE TEST RESULTS PERTAINING TO AN ALUMINUM ALLOY

Kiev PROBLEMY PROCHNOSTI in Russian No 4, Apr 80 pp 45-48 manuscript received 28 May 78

VORONKIN, N. F. and KARLASHOV, A. V., Kiev Institute of Civil Aviation Engineers, Kiev

[Abstract] Fatigue tests of aluminum alloys usually yield results with a wide spread of values. Here an analytical method of evaluating the life and the endurance limit of an aluminum alloy is proposed which does not require plotting of fatigue curves. Accordingly, the stress-cycle test data in semilog coordinates are approximated by a second-degree polynomial with coefficients calculated by the method of least squares. A correlation has been found to exist between the statistical parameters of test data distribution, including probability of fracture, and the fatigue characteristics of the D16 aluminum alloy. An evaluation of this material by this method, based on a 50% probability of fracture, yields results in satisfactory agreement with those obtained by other methods. Figures 1; references 6: all Russian.
[139-2415]

UDC 669,017

ANALYSIS OF RADIATION RESISTANCE OF METALLIZED POLYMER FILMS EXPOSED TO 1,06- AND 10,6-MICRON WAVELENGTH LASER RADIATION

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 2, 1980 pp 3-6 manuscript received 4 Jun 78

VOLYAK, T. B., GALKINA, N. S., KARLOVA, Ye. k., KRASYUK, I. K., PASHININ, P. P., TROFIMOVA, A. A. and SHARAFUTDINOVA, D. E., Moscow

[Abstract] The destruction thresholds of different thicknesses of metallized aluminum, copper, nickel and gold films, applied on polymer substrates and the transmission coefficients of specimens exposed to 1,06- and 10,6-micron laser radiation are measured to find thin metallized films that are promising materials in laser technology for shortening CO_2 laser pulses. The study discloses that gold films on polyethylene terephthalate (PETP) and copper films on teflon are most resistant to 10,6-micron wavelength laser radiation because these metals have higher reflectivity than nickel and aluminum and are the best reflective surfaces on both wavelengths. The examined films can be used in laser systems in place of solid metal mirrors. Figures 2; references 10: 8 Russian, 2 Western.
[124-7872]

UDC 549.2:621.039.61

PHYSICOCHEMICAL PROPERTIES OF TITANIUM CARBONITRIDES SYNTHESIZED IN COLD PLASMA

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 2, 1980 pp 147-148 manuscript received 16 Dec 77

TROITSKIY, V. N. and GREBTSOV, B. M., Moscow

[Abstract] The feasibility of producing a continuous series of anisosubstituted solid solutions of titanium carbonitrides with considerable excess nitrogen is examined. Experiments are conducted on the thermal decomposition of hydrocarbons in a stream of SHF discharge nitrogen plasma to determine the conditions of elemental carbon production. Analyses of the reaction products show that free carbon is a condensed phase in the form of highly disperse powder. The combined hydrogen reduction of $TiCl_4$ and thermal decomposition of hydrocarbons in nitrogen plasma produced titanium carbonitrides which comprise a series of single-phase solid solutions of carbon in titanium nitride with an NaCl structure and general formula TiC_xN_y. The concentration of titanium, nitrogen and total carbon is determined by chemical analysis of the powders. The amount of free

carbon is determined by dissolving the powders in a mixture of nitric and hydrochloric acids. The lattice period of the insoluble precipitate is plotted as a function of the mole composition of the carbonitride phase. Carbonitrides containing more than 8% bonded carbon have more free carbon, the closer the composition gets to titanium carbide. Figures 1; references 8: 6 Russian, 2 Western.
[124-7872]

UDC 535.211:536.21

A WAY TO DETERMINE TEMPERATURE FIELDS AND EFFECTIVE ABSORPTION COEFFICIENT DURING SURFACE FINISHING OF METAL WITH SCANNING LASER BEAM

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 2, 1980 pp 7-10 manuscript received 11 Jan 78

KORNEYEV, V. V. and YAVOKHIN, A. N., Moscow

[Abstract] Different methods are examined for finding the absorption coefficient, necessary for determining the temperature distribution during heat treatment of metal surfaces with scanning continuous laser beam for the pur,ose of hardening steel and iron. The direct calorimetric determination of the effective absorption coefficient on the basis of the ratio of the total absorbed energy to the incident energy is found to offer great advantages in terms of simplicity and precision, and the temperature distribution and temperature field dynamics in a specimen can be found in consideration of temperature errors. Figures 4; references 5: 3 Russian, 2 Western.
[124-7872]

UDC 669.15-194.56; 539.56:539.1.043

RADIATION DAMAGE OF CHROMIUM NICKEL AUSTENITE STEEL BY 1-MeV ELECTRONS IN A HIGH-VOLTAGE ELECTRON MICROSCOPE

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 2, 1980 pp 11-15 manuscript received 17 Sep 79

ORLOVA, A., CHADEK, I., LAZORENKO, V. M. and IVANOV, L. I., Brno Czechoslovakia; Moscow

[Abstract] The radiation resistance of 1Kh18N9T austenite stainless steel as a candidate for the first wall of a first-generation magnetic confinement thermonuclear fusion reactor is analyzed and data are presented on the physics of the formation and spreading of radiation defects in

gamma-solid solution due to electron irradiation at the energy where only point radiation defects occur. Radiation damage in commercial austenite stainless steel is examined in situ at an energy of 1 MeV in a high-voltage electron microscope. Vacuum annealed water-quenched steel foils are used for analyzing radiation damage at 420° C. The kinds of damage that occur under these conditions are described and the results of the analyses indicate that the dislocation loops and pores that occur can cause low-temperature radiation embrittlement of the investigated steel. Figures 3; references 10: all Western.
[124-7872]

UDC 669.1:539.4

CRYSTALLIZATION FEATURES OF NICKEL AND NICKEL-BORON ALLOY FILMS ON REINFORCING FIBERS

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 2, 1980
pp 128-131 manuscript received 22 Nov 78

GOL'DINER, M. G., Kishinev

[Abstract] The features of the chemical crystallization of nickel and of its alloys with boron on carbon fibers and filamentary sapphire crystals are analyzed to determine the influence of surface finish on the structure of films that form on them and on the initial stages of crystallization. The carbon fiber and filamentary sapphire crystals are sensitized and activated to impart catalytic properties, leading to the formation of palladium islands that initiate decomposition of the solution. Sodium boron hydride as a reducing agent causes the joint precipitation of nickel and boron. Films of the alloys are subjected to x-ray diffraction analysis. The results show that the formation of nuclei and sequential activation of active centers, prepared by pretreating the fibers, and the morphologic and structural evolution of the growing film are related to the step by step participation of the components of the alloys in the evolution process. Figures 2; references 5: all Russian.
[124-7872]

UDC 621.315.592.002

ANALYSIS OF ETCHING OF SILICON DIOXIDE THERMAL FILMS BY FREON ION BEAM

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 2, 1980
pp 25-27 manuscript received 11 Apr 79

ANTIPOV, A. N., POZHIDAYEV, Ye. D., IVANOVSKIY, G. F. and TROSHINA, G. S.,
Moscow

[Abstract] The freon ion etching of a thin silicon dioxide film, grown on the surface of monocrystalline silicon, is analyzed by IR-spectroscopy as a promising process that does not require the use of liquid reagents for precision transfer of images of integrated circuits to substrates. The film is etched in stages with a freon-218 ion beam at a fixed etching rate. The study indicates that the etching that occurs is primarily of a chemical nature and that organic contaminants do not precipitate on the etched surface when freon ions are used. Figures 2; references 5: 4 Russian, 1 Western.
[124-7872]

UDC 539.216.2

INFLUENCE OF IONIZATION AND ENERGY OF PLASMA PARTICLES ON STRUCTURE AND PROPERTIES OF ALUMINUM FILMS ON SILICON SUBSTRATES

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 2, 1980
pp 66-72 manuscript received 2 Jan 79

[Abstract] Comparative analyses are conducted on the effect of electron beam plasma sputtering and thermal sputtering on the structure of aluminum thin films and the strength of their bond with monocrystalline silicon substrates in connection with the increasing use of various methods of vacuum precipitation of thin films and coatings from ionized vapor. Films are sputtered onto 250-micron-thick silicon chips, oriented in the (111) plane. After mechanical processing and polishing, the chips are chemically polished in a mixture of hydrofluoric and nitric acids to remove the damaged surface layer and are etched again in 20% hydrofluoric acid priod to sputtering. Examination of the surfaces shows that electron beam plasma sputtering produces a stronger film-substrate bond than thermal sputtering because in ion bombardment most of the energy of the ions is converted to heat due to deceleration of the ions in the near-surface layers of the substrate. The films also have a more equilibrium structure and greater thermal stability and considerably less Al-Si contact resistance. The equipibrium growth of films by electron beam sputtering produces equiaxial grains of uniform size, and the application of negative bias potential to the substrate reduces the grain size in the film. Figures 5; references 16: 5 Russian, 11 Western.
[124-7872]

UDC 178:539.38

METHOD OF EVALUATING AND PREDICTING THE LIMITING STATE OF HEAT RESISTANT ALLOYS UNDER AN ASYMMETRIC MULTICYCLE LOAD

Kiev PROBLEMY PROCHNOSTI in Russian No 12, Dec 79 pp 13-18 manuscript received 28 Mar 78

ISHCHENKO, I. I., GOLUB, V. P., SINAYSKIY, B. N. and POGREBNYAK, A. D., Institute of Mechanics, Academy of Sciences UkrSSR, Kiev

[Abstract] A method is proposed for evaluating the time to crack formation as well as the rate of crack development under conditions of cyclic fatigue and creep for a moderate increase in temperature. Using EI867 and VZhL12U alloys at 900 and 1000° C, respectively, for periods of 10 and 100 hours, experimental data were obtained which make it possible to show that the principles of damage accumulation under these conditions differ considerably in each of the two stages of fracture. In the stage of crack formation a negative nonlinear interaction of static and fatigue damage can be observed while in the stage of crack development this interaction is absent and the rate of crack growth for the combined action of fatigue and creep can be determined by a simple summation of crack growth rate under conditions of each of these forms of failure. Figures 3; references 15: 10 Russian, 5 Western.
[87-6368]

CSO: 1842

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